DETERMINING FACTORS OF CANADIAN MILK QUOTA PRICES

by

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ABSTRACT

Issues regarding the effects of supply management systems, seem to attract special attention from the industry, policy makers, and academic environments. The Canadian dairy industry is no exception. In addition to higher milk product prices for the consumer, the milk marketing quota is perhaps the most debated side of the dairy supply management regime. The milk quotas were initially allocated to each farmer, and are now traded openly in most provinces through a milk quota exchange. Substantial variation in milk quota prices can be observed in the last 15 years as compared to the TSE 300 Stock Price Index.

The objective of this research is to analyze and explore why the large variation in observed milk quota prices in the 1980's and 1990's occurred, and to reveal the factors that are important for the formation of milk quota prices. Two factors are the focus of this thesis, one is the uncertainty regarding the future of the supply management system, especially during the two major trade negotiations, GATT and CUSTA, that took place in the late 1980's and early 1990's. The second is the expectations of future returns from holding milk production quotas that were formed in the presence of this uncertainty.

Based on a standard capitalization model, three price functions are derived. Using an adaptive expectation framework, and one of the most complete data sets collected for the purpose of analyzing quota prices and quota issues in Ontario, Quebec, and Alberta, the estimated results suggest that, in general, unit changes in the net profit variable are important in MSQ pricing, more so for Used MSQ prices and fluid milk quota prices, than Unused MSQ prices. This supports the impression that fluctuations in Unused MSQ prices are partly driven by short-run considerations to avoid over-quota and maintenance penalties. The adaptive

expectation model provides better results when explaining the formation of MSQ prices than fluid milk quota prices. This analysis also concludes that the milk quota auction is not a perfectly understood marketplace, and that several puzzles remain to be explained in future work.

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Nature's first green is gold,
Her hardest hue to hold.
Her early leaf's a flower;
But only so an hour.
Then leaf subsides to leaf.
So Eden sank to grief,
So dawn goes down to day.
Nothing gold can stay.

Robert Frost, 1923

CHAPTER 1

1. INTRODUCTION

1.1 Problem Setting

Many production schemes in Canadian agriculture have operated under a supply management system. The egg, broiler, and dairy industries are some examples (Barichello 1982). One of the main factors created by the dairy supply management system is the milk production quota. The ownership of quota gives the holder the right to market a specified amount of milk at a regulated price level. These quotas present a unique opportunity to examine the effects of government programs directly, because the return from holding the quota is dependent entirely upon these programs.

Following the Uruguay Round Agreement of the General Agreement of Tariffs and Trade (GATT), most non-tariff measures, including the import quotas of Canada's supply management system, were converted to tariffs. This would appear to signal the end of the supply management regime, and its associated milk marketing quotas. However, the newly specified tariffs are so high that Uruguay Round Agreement phase-outs to the year 2000 will have little effect on trade, and domestic marketing quotas will therefore be an important feature in the supply managed industries for many years.

One main question that has to be challenged when working with quota markets is, are these markets are rational and meaningful? The answer is critical if we want to reveal and use information from quota markets to answer questions surrounding the supply management system. One such question is, are quota prices are stable and predictable, implying that dairy producers can use and trust market information as rational. Another is, if the regime were to fall, then would there be some compensation to quota holders, and if so, could quota prices as

observed at quota exchange markets, be used as a basis for compensation? By pursuing these questions it might be possible to gain useful experience based on past information in the quota markets, such that milk producers, policy makers and public organizations can make the best decisions in the future.

1.2 Problem Statement

The quota price is made public through the provincial milk marketing board's quota exchanges. Figures 1.1, 1.2, and 1.3 provide the Unused[1] and Used industrial milk quota prices together with the fluid milk quota prices for the provinces of Ontario, Quebec, and Alberta. The fluctuations in quota prices are striking, and the price variation in fluid milk quota, the quota type with the least variation, is 30 percent larger than the variation in the TSE 300 Stock Price Index during the same time period (Barichello and Chen 1996). The observed quota prices increased in the period from 1981 up until 1986, followed by a declining trend that reached the bottom in 1990. Quota prices have since then increased. The price changes are significantly larger for MSQ compared to prices of fluid quota, and these price changes are also larger in the provinces of Ontario and Alberta as compared to Quebec. There is also observed substantial variation within a dairy year[2], but this variation is plausibly mainly a result of institutional regulations and seasonality in production costs.

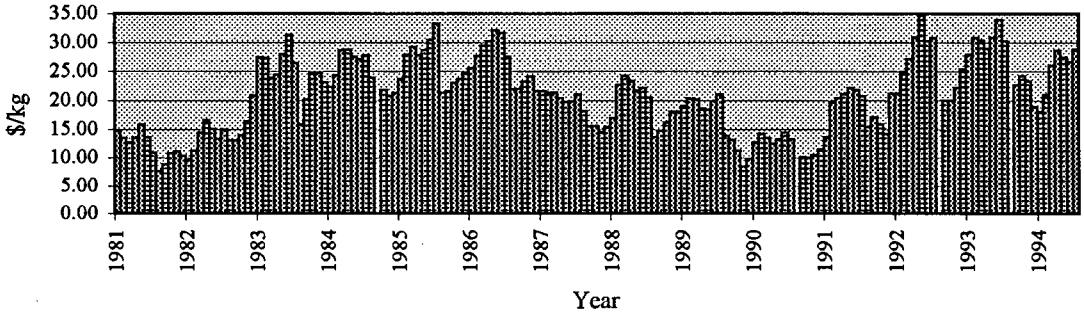
Can this variation in milk quota prices be explained? Several authors have investigated milk quota issues in Canada (Barichello 1984; Lermer and Stanbury 1985; Barichello and Dunlop 1987; Saint-Louis and Proulx 1987; Moschini and Meilke 1988;

[1] There are two types of milk quotas in Canadian dairy industry. Class 1, or fluid milk quota, and the industrial milk quota, also called Market Share Quota (MSQ). For a detailed description, see Chapter 2.1.
[2] The dairy year goes from August 1 to July 31.

Figure 1.1: Ontario Quota Prices

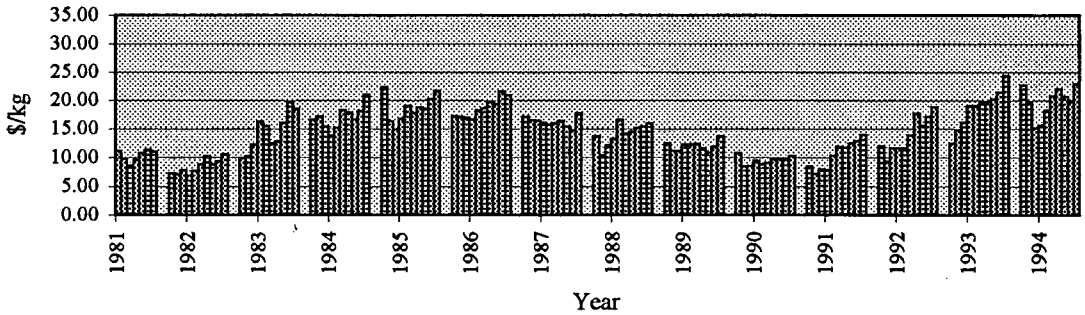
I

Unused MSQ prices, CPI adjusted, ONTARIO, Jan.1981 - July 1994



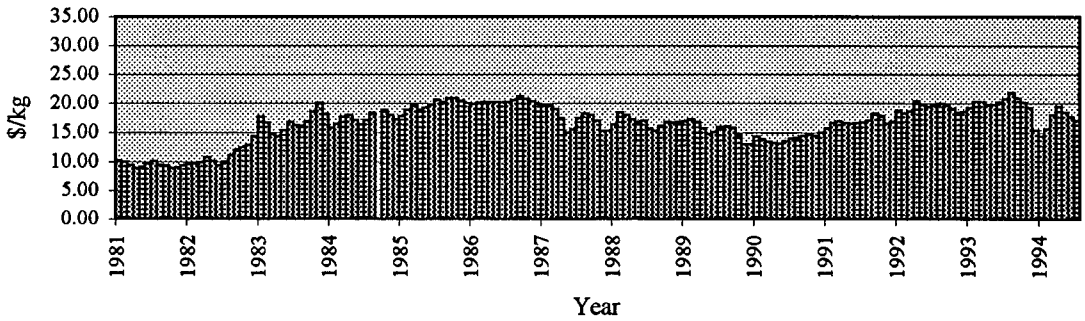
II

Used MSQ prices, CPI adjusted, ONTARIO, Jan.1981 - July 1994



III

Fluid Quota prices, CPI adjusted, ONTARIO, Jan.1981 - July 1994

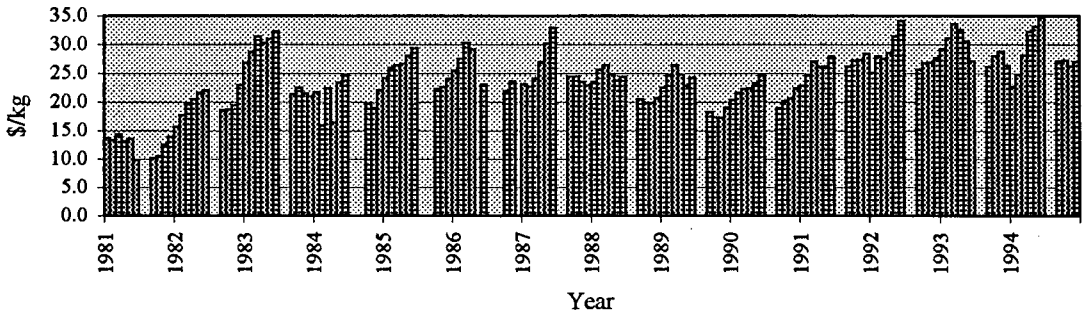


Source: Dairy Farmers of Ontario

Figure 1.2: Quebec Quota Prices

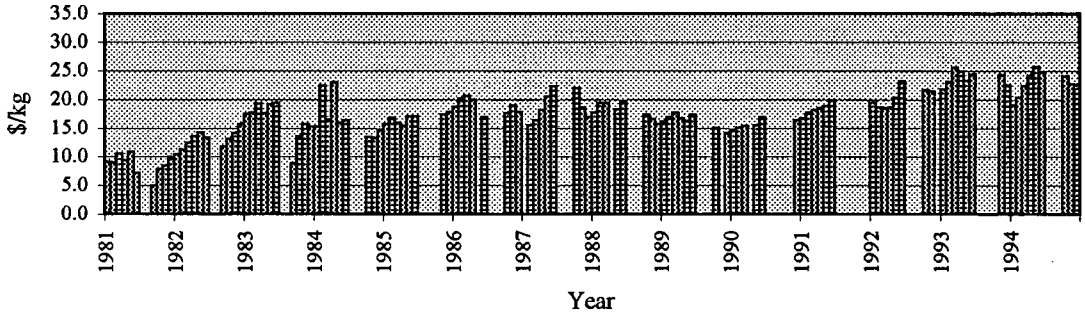
I

Unused MSQ prices, CPI adjusted, QUEBEC, Jan.1981 - Dec.1994



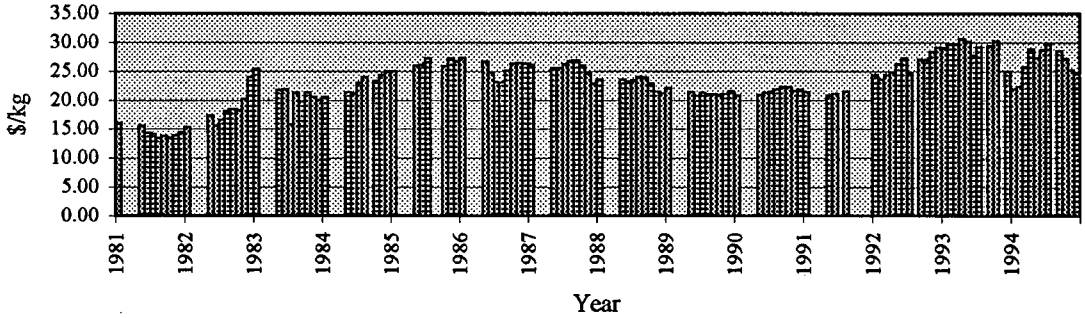
II

Used MSQ prices, CPI adjusted, QUEBEC, Jan.1981 - Dec.1994



III

Fluid Quota prices, CPI adjusted, QUEBEC, Jan.1981 - Dec.1994

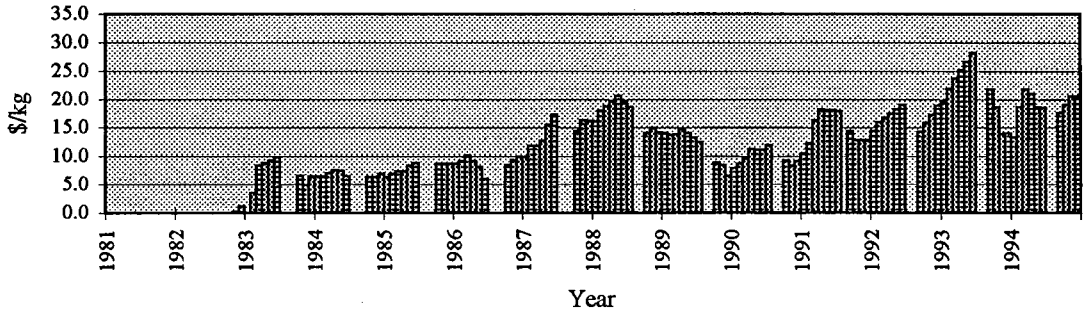


Source: Dairy Market Review

Figure 1.3: Alberta Quota Prices

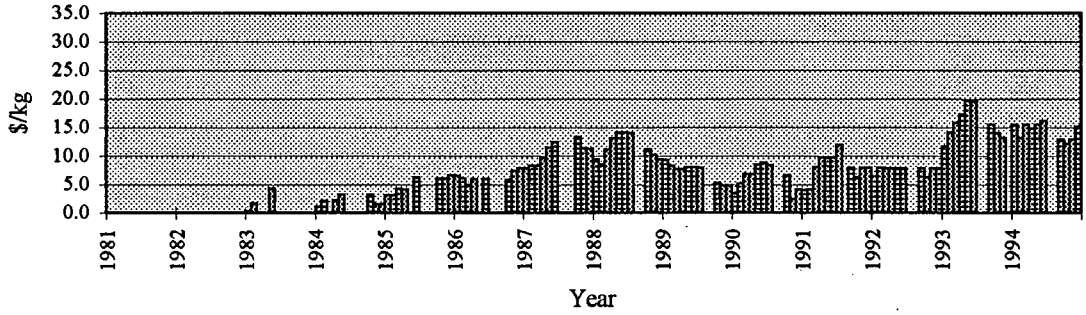
I

Unused MSQ prices, CPI adjusted, ALBERTA, Jan.1983- Dec.1994



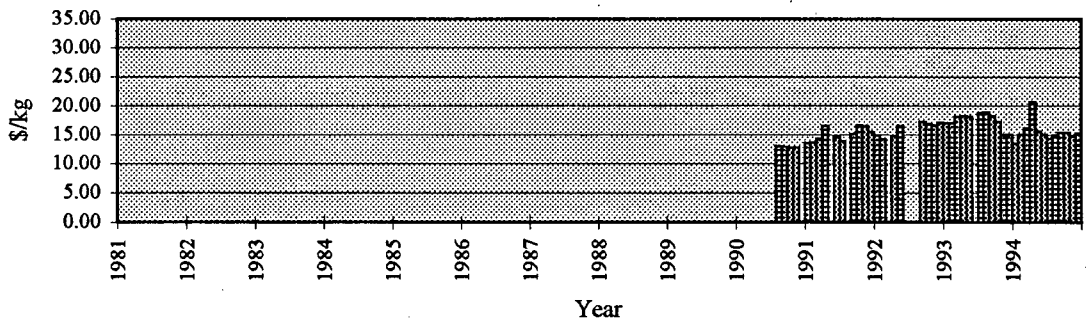
II

Used MSQ prices, CPI adjusted, ALBERTA, Jan.1983- Dec.1994



III

Fluid Quota prices, CPI adjusted, ALBERTA, Aug.1990 - July 1995



Source: Dairy Market Review

Barichello and Stennes 1991; Beck et. al. 1994; Larue 1994; Meilke and Chen 1995; Romain and Lambert 1995; Veeman and Dong 1995; Barichello and Chen 1996) and a few critical factors seem to be agreed upon when explaining the formation of milk quota prices. Based on a standard capitalization model, as used when explaining land values, most authors are concerned about calculating the yearly profit from holding quotas and revealing the implied discount rate from observed milk quota prices. The traditional determinants in a capitalization model are well investigated and can partly explain the formation of milk quota prices. What is not so well explored, is how determinants due to institutional factors influence the formation of milk quota prices, such as, what impact has the risk of dismantling the current supply management system had on quota prices.

1.3 Objective

The objective of this research is to analyze and explore why the large variation in observed milk quota prices in the 1980's and 1990's occurred, and to reveal the factors that are important for the formation of milk quota prices. One such factor is the uncertainty regarding the future of the supply management system, especially during the two major trade negotiations, GATT and CUSTA, that took place in the late 1980's and early 1990's. Another, is that expectations of future returns from holding milk production quotas occurred in the presence of this uncertainty.

To be able to succeed with this, the focus will be concentrated on three different areas: (1) an understanding of the dynamics and regulations in the quota markets, (2) the expectations of future profit from holding quota, and (3) the political risk associated with a supply management system. These three areas will be embedded in a complete model of quota prices.

The work will be based on the existing literature, and the data applied in the time period from 1980 to 1994. The three largest milk producing provinces in Canada; Quebec, Ontario, and Alberta will be analyzed, and similarities and dissimilarities will be discussed.

1.4 Thesis Outline

Chapter 2 will provide the necessary background information on Canadian dairy quota markets. Chapter 3 is divided into three different parts, and provides the theoretical background for the work. The first part provides a review of relevant literature. The second part analysis a survey of how dairy producers use quota markets, suggesting an extension of the simple capitalization model. The third and last part in Chapter 3, analyses theoretical aspects of dairy production, ending up with a theoretical model framework based on adaptive price expectations. Chapter 4 defines and describes the variables that are potentially important in the search for answers to how milk quota prices are formed, and suggests a set of price functions for milk quotas, including the empirical model. Chapter 5 presents the necessary data for estimation of the empirical models and describes the research methodology. The results from the estimation, and the analysis of the proposed price functions, are presented in Chapter 6. Finally, conclusions are drawn in Chapter 7.

CHAPTER 2

2. BACKGROUND INFORMATION ON DAIRY QUOTA MARKETS

2.1 Milk Quotas

There are two types of milk quotas in the Canadian dairy industry. Class 1, or fluid milk quota, and the industrial milk quota, also called Market Share Quota (MSQ). The MSQ has usually been divided into two quota types, "Unused" and "Used quota". Unused MSQ is MSQ that can and must be utilized in the current dairy year, while Used MSQ milk cannot be utilized until the next dairy year (after July 31). After this date there are no differences between the two types of MSQ. Fluid milk quota can and must be utilized on a daily basis.

The quota amount at farm level can be adjusted up or down by the Milk Marketing Board if the market conditions change, but these changes tend to be marginal. With this exception, the quota holder can expect to deliver the quota amount for an infinite number of years. Until now, there has been no trade of quota between provinces and quota rental has been prohibited in most provinces or otherwise discouraged[3]. The size of the fluid milk quota has been decided by consumer demand in each province, while the total MSQ has been distributed to each province, by a federal-provincial committee, based on historical production levels[4]. There are no restrictions on trade with industrial milk products between the provinces, while fluid milk is supplied from within each province.

[3] This will change after August 1, 1996, when a quota exchange system between Quebec, Ontario, New-Brunswick and Nova Scotia will be implemented.

[4] For a more detailed description of the transfer policies, see Barichello and Chen (1996).

2.2 The Current Quota Exchange System

Milk quotas may be transferred among producers within a province in three different ways:

- within-family transfers,
- on going farm sales, and
- quota exchange

Within-family transfers take place between parties who are not dealing at arms length. Where the farm, herd and quota are purchased as a unit, there is no possibility to observe the value of the quota separately. Thus, the only quota transaction where prices are made public, are trade that take place on the exchange market. Only in this market is the price of quota reported separately from the price of other assets by buyers and sellers dealing at arms length. To indicate the extent of quota transfers, 0.51% of total Ontario quota in 1993 was sold at the quota exchange. The within-family transfer was 2.37% of total quota amount.

The provinces of Ontario, Alberta, and Quebec, manage their provincial quota exchange through each province's Milk Marketing Board (MMB). The participants in the quota market send in their sealed bids and offers to the MMB. Included in the bid, is the requested amount of quota, the bidders reservation price, and a financial guarantee for the value of the potential transaction. Included in the offer is the amount of quota for sale, and the reservation price. Each player can only participate once per auction. The MMB will, at a given date every month, match the bids and offers to clear the market. The successful players will have a transaction, while others have to consider participating in next months auction.

2.3 Milk Prices

The Canadian Dairy Commission (CDC) determines the target price at the beginning of the dairy year, guided by a "returns adjustment" formula before 1988 and by a full cost of production pricing formula in and after 1988. To determine the support price, the CDC uses the following formula:

$$\textit{Target price} = \textit{butter support price} * \textit{butter yield} + \textit{skim milk powder price} * \textit{skim milk powder yield} - \textit{processor margin} + \textit{direct subsidy},$$

where the butter and skim milk powder yields are the assumed number of kilograms of butter and skim milk powder produced from one hectoliter of milk. The processor margin is meant to represent the non-rawmilk costs of producing the joint products, butter and skim milk powder. The fluid milk price is usually determined through a cost of production formula by each of the provincial milk boards. All provinces charge a higher price for fluid milk than for industrial milk, even though the raw milk is identical. Dairy farmers have traditionally been paid a premium based on the butterfat contents in their milk, since a high butterfat percent made the milk more valuable for the processors. However, consumers demand for lower fat milk products has encouraged some provinces to change to a multiple component pricing system, where the milk is paid for on the basis of the contents of butterfat, protein, and other milk-solids. Ontario implemented this system in January 1992, and Quebec in August the same year. In Alberta, the milk is still paid for on a butterfat basis.

The price variation between these three provinces is larger for fluid milk than for industrial milk. Ontario has the highest price level for fluid milk, followed by Quebec and Alberta. Because more fluid quota is issued in aggregate than is needed to cover total consumer

sales of table milk, not all milk shipment covered by fluid quota receive the higher fluid milk price. That proportion eligible to receive the fluid milk price is refereed to as the payout percentage. However, the payout percentage varies over months/years, and in the period between 1980 and 1994, the payout percentage in Ontario ranged between 60% and 78%.

The provincial milk marketing boards administer payments from processors to dairy farmers. This allows several deductions to be made, as legislated in national levy rates. The deduction structure varies between milk for industrial purposes and fluid milk. The "within-quota" levy is supposed to cover some of the extra costs when the excess production of industrial milk products has to be sold abroad at world market prices. Milk which is shipped as fluid milk from the farm, is also classified as fluid milk under the national supply management program. This milk is not eligible for the subsidy received on industrial milk[5], and is not subject to the within-quota-levy collected on all MSQ shipments. The "skim-off" levy is related to the residual butterfat left over from the processing of fluid milk and cream products. The "over-quota" levy is significantly higher. This over-quota levy is really the enforcement in a quota supply management regime, because the levy should be set at a level that discourages producers from over-supplying their market shares. If a province's total production quota is not exceeded, the over-quota levy may be refunded to the penalized producers. If not, the levy will partly pay for the surplus disposal costs involved.

[5] The direct subsidy on industrial milk will in the future be reduced to zero.

CHAPTER 3

3. THEORETICAL CONSIDERATIONS

3.1 Literature Review

Given the objectives of explaining the formation and variation in milk quota prices, the first step will be to build a solid theoretical model. Several authors have already carried out work with similar objectives, and the next section will provide a short summary of their results. An investigation of these results might reveal useful information for the creation of a theoretical model.

3.1.1 Deriving Rates of Return

The formation of milk quota prices has traditionally been explained by use of a similar approach as the more extensive land capitalization theory. The most widely accepted explanation of quota prices is that the quota price equals the present value of expected future rents, discounted by a chosen discount factor. Using this simple asset pricing formula, most studies are concerned with deriving the rate of return from observed prices (Barichello 1984; Moschini and Meilke 1988; Meilke and Chen 1995). This rate should account for elements such as the risky nature of the asset, expected capital gains, expected interest rates, and planning horizons. The estimated rates of return vary across quota types, period of time and province, in the range of 0.10 to 0.38 percent, with the majority of the results in the upper end of the scale. When the discount rate is greater than the return on assets, this is usually interpreted as an additional compensatory risk premium, and high discount rates implies that the milk producers require a short pay back period of their investment in additional milk quota. If the rate of return is 0.25, this means that no longer than an expected 4 year pay back period of a quota purchase is

required. Since even higher rates of return are observed, this suggests that milk quota holders are skeptical about the income possibilities from holding this quota in the future.

Moschini and Meilke (1988) presented Ontario rates of return for Unused MSQ slightly below those of Used MSQ, and partly explained this by the fact that Unused MSQ can be used by producers to avoid the large over-quota penalty toward the end of the dairy year. They also note the striking feature of the large difference between the rates of return of fluid and industrial milk quota values, the former being consistently higher than the latter. A possible factor is that Ontario dairy farmers cannot hold more than 75% of their total quota as fluid milk quota. However, given that less than half of the total quota available in Ontario is in terms of fluid milk quotas, this constraint cannot be binding for all producers, thereby leaving open the possibility of bidding up the price of fluid milk quota. An alternative explanation is that the risk premium associated with fluid milk quotas, is much higher than the risk premium on industrial milk quotas. This is consistent with the observation that, as monopoly rent increases, it is likely to become more difficult to defend the supply management system politically.

Despite the appealing theory behind the simple asset pricing formula, a demand for a more advanced theory arose, in considerable part due to difficulties in estimating the marginal cost of production. A correct estimation of this variable is critical since it indicates the possibilities for future income streams. Barichello and Stennes (1991) have pointed out that milk production cost analyses most likely is biased upwards due to difficulties inherent in using farm cost survey data. Since this data is gathered for the purpose of determining milk prices, and farm records are kept for tax purposes, this gives a clear incentive to respondents to bias upwards their responses, in terms of prices, values, and input quantities. Barichello (1984) utilized therefore an alternative measurement of net return. The special characteristics in the

organization of the industrial milk quota, make it possible to estimate the net return in the short run. Since the only difference between Unused and Used MSQ is the requirement that Unused MSQ must be utilized before July 31, the difference in price between the two types of quotas should be equal to the rental rate. Producers who traded quota on the Unused market, would most likely be doing so for quota management reasons, and the difference between Unused and Used prices would be an annual return, determined by short-run considerations. By taking the ratio (Unused price-Used price)/Unused price, from 1980 to 1990, Barichello presents average rates of return implied by industrial milk quota prices, in the range of 0.26 percent in Quebec to 0.36 percent in Alberta.

Meilke and Chen (1995) used the same measurement of net return as Barichello (1984). The empirical implementation of their dynamic optimization model provides various results regarding the rental rate. The authors concluded that even if the difference between Unused and Used MSQ provides a conceptually correct way of measuring rental rates, this method often produces unrealistic results. It is worth noting that the authors found that risk for a dismantling of the current supply management system has no effect on the calculation of the equilibrium rental value of quota, although the majority of other work done within this area for the past decade, are highly concerned about such an effect.

3.1.2 Quota Regulations

As noted by Barichello and Dunlop (1987) and Barichello and Chen (1996), it is not possible to analyze the milk quota regime without carefully considering the effects of regulatory restrictions.

Barichello and Chen (1996) included all the main regulations restricting trade, as over-quota levy, maintenance clause, and assessment tax, in their model. The results from the empirical estimation strongly support the view that dairy farmers operate to maximize their profit. Evidence for a rational decision process regarding quota trade, is very important when the effects of quota regulations should be interpreted on observed data. The same effects have also been examined by other authors. Chen and Meilke (1995) evaluated the effects of the transfer assessment tax that is levied on the sale of milk quota. Knowledge of the elasticity of the supply and demand for quota seems to be required to estimate the rental rate, and the transfer assessment forces the quota price upwards. Romain and Lambert (1995) include the over-quota levy in their demand function for quota. They note that the over-quota levy significantly affected Used MSQ in Quebec and Ontario, and Unused MSQ in Ontario.

In the work of Saint-Louis and Proulx (1987), the deviations from a perfect market are emphasized. Most analyses of the quota regime assume that the difference between a free commodity market price and quantity equilibrium, resulting from the supply management system, is the only basis for evaluating the true costs of the quota existence. Imperfect mobility of capital and labour, especially in regions where supply managed marketing boards are used, to alleviate rural adjustment problems, support the argument that the concept of a supply management system should be described more in details. It is also observed that average commodity production costs, calculated under the governmental supervised accounting system, are used in Canada as a reference for establishing milk prices. For that reason, the market price of milk can be lower than the optimal milk price for a pure monopolist.

Barichello and Dunlop (1987) noted that quota markets can be very thin, and that this also has to be kept in mind when interpretations and conclusions about the quota markets are drawn.

3.1.3 Development of Costs

To capture production cost side effects on quota prices, both Romain and Lambert (1995) and Veeman and Dong (1995) included productivity measures in their models. Romain and Lambert compare many different effective variables between Ontario and Quebec in their work. This study presents an alternative analysis compared to most of the written material within this field. A farm oriented angle is emphasized, where a number of variables are analyzed. They use milk sold per cow as a measure of productivity. In the explanation of industrial milk quota prices, this variable turned out to be significant, but negative, a result that is inconsistent with economic theory. It also seems to be a common problem in the results that the signs of the variables turn out to be reversed for the two provinces, which makes it rather hard to interpret some of the coefficients. Veeman and Dong (1995) evaluated three different productivity measures; milk sold per cow, time trend, and herd size. They consider herd size to be the most appropriate measure of productivity and the variable significantly effects fluid quota prices positively in Ontario in their empirical work.

3.1.4 Political Risk

In the variety of different risk types, political risk is often emphasized in the milk quota literature. The term, political or policy risk, is often used to decide the risk of a change in government policy that will reduce or eliminate the extra income due to the current policy. The

GATT and CUSTA negotiations that took place in the late 80's and early 90's are two of the major political events with implications for the milk producers' risk perception. How these negotiations have influenced the supply management programs in the Canadian agriculture, have been examined by several authors (Lermer and Stanbury 1985; Larue 1994; Beck, Hoskins and Mumay 1994; Barichello 1995). Political risk arises due to a belief that the balance of political power that sustains a quota system may change in the future, and alter or end the stream of future rents that the milk producer expects to receive. By assuming that most milk producers are risk averse, the presence of political risk will therefore lower the milk quota prices.

By introducing a variable for the probability of a change in the dairy regime, Barichello (1984) extends the asset pricing formula to include political risk. His calculations of this default risk, indicate it to be in the range of 0.15 and 0.20 percent, a subjective probability of between one in five and one in seven that the quota regime would be ended. He also revealed that the default risk evident in Quebec, in the range of 0.12 to 0.15 percent, was lower than that found in the rest of Canada. This is consistent with the pre-eminent role played by the Quebec dairy lobby in the determination of industrial milk policy in Canada, and hence the lower political risk in the minds of Quebec dairy farmers.

Veeman and Dong (1995) hypothesized that an adverse GATT panel ruling on the legitimacy of Canada's import quotas for ice cream and yogurt, may contribute to lower quota prices during the first few months of 1990. They measured the political risk by introducing a time policy dummy variable into their empirical model, and found that this measure of policy risk effected quota price significantly and negatively.

The GATT and CUSTA negotiations likely altered the milk producers perception of risk and uncertainty. Larue (1994) examines the results from the negotiations, and argues that the

supply management system obtained a secure position for the foreseeable future in the final round. His argument is that the tariffs introduced as part of the Uruguay Round of GATT still are highly prohibitive, and that the proposed tariff reductions will leave the prices of supply managed commodities unaffected by tarrification, for at least ten to fifteen years. This would have the effect of reducing risk, compared to some of the pre-negotiation scenarios.

Lermer and Stanbury (1985) conclude that where regulatory regimes severely restrict the transfer of quotas, producers absorb all or a large part of the risk. This increases social costs and reduces the net transfer benefit to producers that is imputed by using the risk-free rate of interest. The authors claim that this is not to say that the quota values as they are found in the market, reflect anything other than the net transfer benefit anticipated by producers. The practical implications from their results are uncertain.

In the treatment of risk, Beck, Hoskins and Mumay (1994), compare the quota risk with investment in a broad Toronto Stock Exchange (TSE) portfolio. The historic TSE risk premium is cited by Ross *et. al.* (1993) to be 7% from 1948-90 and 4% from 1973-90. They also argue that quota risk might not be comparable with TSE risk. Farmers' political relationship and knowledge may allow them to estimate some approximate boundaries for expected quota life. In addition, farmers might have diversified some of their quota risk if they are holding substantial non-quota investments. As an initial approach in the empirical section, the 4% risk premium is chosen. A 3% real riskless rate is also used, approximately consistent with Canadian historical rate. Ross, *et. al.* (1993) cite a return on long-term Canadian bonds of 2% in excess of inflation from 1948-90 and 4% from 1973-90. Analyzing the use of these parameters in a logarithmic capitalization model, the authors comment that the 4% risk premium is probably too low, supporting the argument that very high discount rates are applied in the milk quota market.

Turvey et. al. (1995) argue that high rental rates used to capitalize quota are unlikely only due to a risk premium induced by political risk, since high capitalization rates are observed over an extended period of time. They note that the institutional lending structure prohibits quota to be used as security and rarely provides loans for quota purchases of greater than 5 years duration. This practice requires all loans to be self liquidating and requires a payback period of 5 years, at most. In order for this to occur, farmers must capitalize quota at a higher rate than would ordinarily be used to discount future returns.

3.1.5 Summary

Most authors seem to use the same fundamental factors in their applied capitalization models, and in most studies are also the estimated results similar. The rental rate variable and the discount factor obtain the major attention in these studies. The rental rate is calculated in two different ways, either based on observed milk prices minus estimated production costs (usually from production cost surveys), or by using the price difference between unused and used MSQ. The analyses of the discount factor can be divided into three different parts; the risk-less rate, risk compensation, and policy risk. Most authors argue that the risk-less rate and the risk compensation, have been above 4-7%. The size of the political risk compensation is more uncertain, but it seem commonly accepted that this compensation is substantially higher. Most authors found that higher political risk in general negatively influenced quota prices, and that the high revealed discount rates support the presence of uncertainty about the future of the supply management system. What is not so deeply investigated, is what causes the political risk compensation? To be able to understand more of the functioning of milk quota markets, it seems to necessary to look deeper into this area.

3.2 Entering the Quota Exchange

3.2.1 Analysis of Marginal Costs

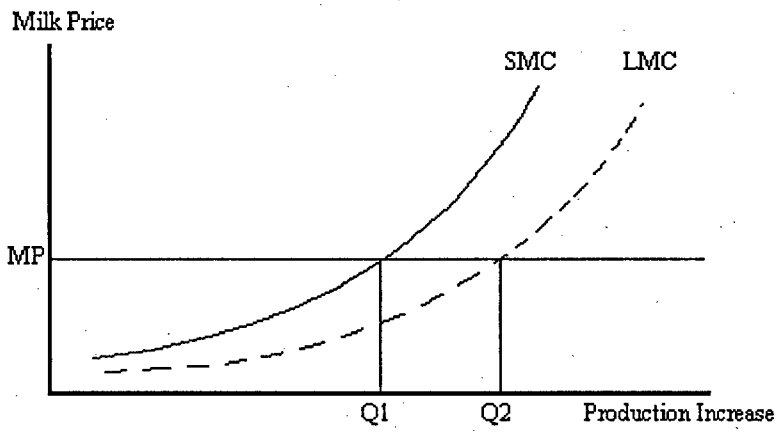
For quotas to have value at all, marginal costs must be below marginal revenues at the margin of production. Further, it is reasonably to expect that marginal costs increase as production increases, since when dairy farmers feed their existing cows more feed to obtain extra milk, the additional costs will be quite low. If the producers have to buy additional cows, their additional costs will be higher, and if they have to build a bigger barn, the costs will be higher still. Thus, we can depict the marginal cost curve to be convex, rising to the right as output increases. A milk producer with marginal cost curve equal to SMC (short-run marginal costs) can never expand her production past level Q1, since the margin between milk price MP and marginal cost of production turns negative beyond this level, and never forms the basis for a competitive bid in the quota market.

All fluid quota holders also hold some MSQ, and when shipping milk, the fluid milk quota part will first be covered, then the rest of the shipment will be deducted from their MSQ. Quota adjustments, due to the maintenance penalty and the over-quota levy, will therefore normally be covered at the Unused MSQ market exchange. The market for Unused MSQ will therefore be strongly influenced by milk producers actions to avoid these penalties, and especially closer to the end of the dairy year.

In a longer-run perspective the situation can be different. Due to economies of scale, the farm's production system can be utilized in a more efficient way with larger production. The long-run marginal cost curve (LMC) is located to the right of SMC curve in Figure 3.1, and opens up the possibility for a profitable production increase equal up to level Q2. The fluid quota and the Used MSQ markets are under influence of both short- and long-run

considerations, but in compared to the Unused MSQ market, a main emphasis will be on long-run considerations.

Figure 3.1: Short- and Long-Run Marginal Costs



This explanation is given empirical support from the Ontario Milk Marketing Board's survey of the quota trade in their province between March 1980 and February 1987, and is based on 27,728 quota trades. When comparing the transactions of the three quota types, the average purchase of Unused MSQ was 13,875 liters. The average purchase of Used MSQ was 21,185 liters, and the average purchase of fluid milk quota was 20,769 liters. When the average purchase of Unused MSQ is close to 7,000 liters below the two other quota types, this is partly caused by the different planning horizons for the three quota types.

3.2.2 Incentives to Operate in the Quota Market; Description of a Survey

A survey that examined milk quota issues at a farm level, was conducted in Ontario between March 1980 and February 1987, and commissioned by the Dairy Farmers of Ontario[6]. The survey provides useful information about the underlying structure of decisions by quota

[6] Notice, that the survey only took place among farmers who willingly participated.

holders to participate in the quota market. Tables 3.1 and 3.2 rank the survey responses for why milk producers participated in the quota exchange. A number of incentives appear to have importance for the decision to make a bid for quota, as ranked in Table 3.1.

Table 3.1: Important Factors Influencing Producers Decisions to Bid for Quota

	Group 1 Pool		Unused MSQ		Used MSQ	
	No.	%	No.	%	No.	%
Higher return than MSQ	95	32.7	-	-	-	-
More secure than MSQ	60	20.6	-	-	-	-
To avoid over-quota penalty[7]	40	13.7	104	41.4	14	28.6
Production per cow increased	43	14.8	67	26.7	7	14.3
Increased number of milk cows	18	6.2	47	18.7	11	22.4
Appeared to be a good investment	17	5.8	19	7.6	7	14.3
To cover 75% of milk shipments	14	4.8	-	-	-	-
Quota price relatively low	4	1.4	6	2.4	6	12.2
New entrant	-	-	7	2.8	4	8.2
Other	-	-	1	0.4	-	-
Total	291	100	251	100	49	100

Source: Field survey data, Ontario Milk Marketing Board

Most interesting in this context, is how fluid quota holders compare fluid quota and industrial milk quota with respect to security and the expectations of return. More than 50 percent of the producers in the survey answered that these two factors were the most important, strongly indicating that risk evaluation and expectations of return is perceived as significant factors in the bid process. Different circumstances, such as diseases, nutrition value in the feeds being used, and length of the grazing season, affect the average milk per cow. It is therefore

[7] When the producer exceeds his quota, the excess milk will obtain a lower price. The average over-quota levy, for the period 1980 to 1994, was close to $8/ hl.

difficult to plan exactly the total milk production in advance. Throughout the dairy year, producers will be more aware of the status of their quota situation, and some producers realize that they can not fill the quota before the end of the dairy year, and must make quota size adjustments to avoid over quota penalties. As seen in the table, this is the most important factor for buying Unused MSQ. Increased production, either per cow or in total number of cows, is also revealed as an important factor for buying quota.

Table 3.2: Important Factors Influencing Producers Decisions to Sell Quota

	Group 1 Pool		Unused MSQ		Used MSQ	
	No.	%	No.	%	No.	%
Quit dairy farming	33	37.9	41	30.6	38	48.1
Reduced workload	21	24.1	20	14.9	14	17.7
Quit farming	12	13.8	13	9.7	10	12.7
Avoid maintenance penalty[8]	6	6.9	33	24.6	1	1.3
Financial restricting	6	6.9	10	7.5	6	7.6
Catastrophe (fire, disease, etc.)	5	5.8	6	4.5	3	3.8
Increased group 1 quota	-	-	6	4.5	4	5.1
High quota price	4	4.6	4	3.0	3	3.8
Other	-	-	1	0.7	-	-
Total	87	100	134	100	79	100

Source: Field survey data, Ontario Milk Marketing Board

Major incentives to sell milk quota can be seen in Table 3.2, with the highest rank given to quit dairy farming and to reduce workload. For Unused MSQ, avoidance of maintenance penalties is also given as an reason to sell quota. As the dairy year precedes, some dairy

[8] The owner of a MSQ quota commits to deliver 85% of the quota amount within the dairy year. A violation of this commitment will implement an adjustment of the next year's quota, and thereby a economical loss, since the unused part of the quota could have been sold.

producers realize that are not able to fill the quota. The clause might force the producers to respond. Livestock can be bought, or part of the quota can be sold.

The analysis of the Ontario survey, suggests that short- run factors, as to avoid over-quota levy and to avoid maintenance penalty, do have a higher impact on the Unused MSQ market than the market for Used MSQ and fluid milk quota. We can also expect the activity in the industrial quota exchange market to increase throughout the dairy year, since the maintenance clause, the over-quota penalty, and the possibility to capture rents, put pressure on the last part of the trading season.

3.3 Substitution Between Quota Types

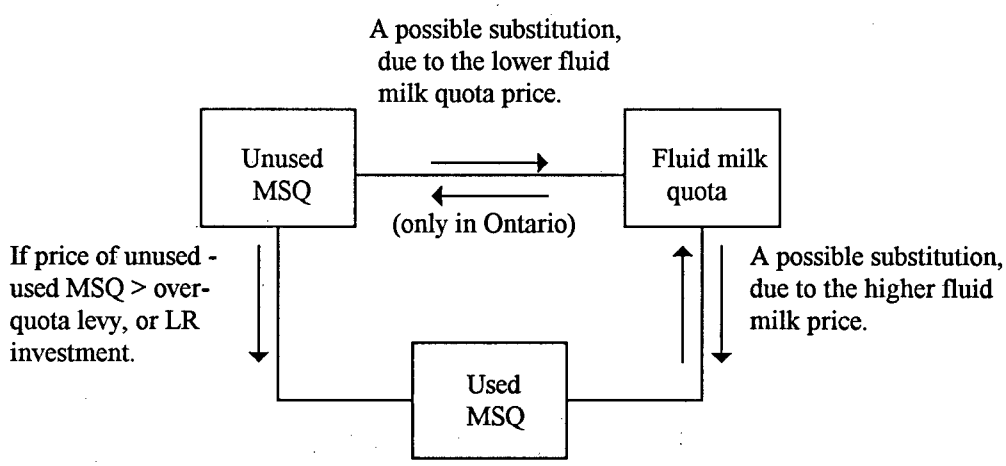
Dairy farmers have, to a certain extent, the opportunity to chose between the different quota types (Please see Chapter 2.1: Milk Quotas). The dominant incentive for buying Unused MSQ is the necessity of getting milk shipped before the end of the dairy year, such that over-quota penalties can be avoided. Alternatively, milk producers can buy fluid milk quota.

A similar analysis can be done when a purchase of Used MSQ or fluid milk quota is considered. But the decision making here is more complicated. Due to the high price on Unused MSQ compared to the price of Used MSQ, a purchase of Unused MSQ will not be an alternative when the producer plans to maintain or increase the production level of industrial milk in the next dairy year. And since there are no maintenance requirements on this quota type before the next dairy year, production can also be adjusted at a lower cost. In this perspective, more fluid milk quota might be perceived as a reasonable alternative, due to the fact that fluid milk is paid at higher price than industrial milk, and that the price of fluid quota is lower than the price of Unused MSQ.

The prices of Used MSQ do not vary independently of the Unused MSQ market. It would seem that the price gap between Unused and Used MSQ should never exceed the over-quota penalty. If this were to happen, the producer would be better off purchasing Used MSQ for utilization the next production year, and pay the over-quota penalty for the excess production this year.

Buying Unused MSQ instead of fluid milk quota is no real alternative since the price of Unused MSQ never drops below the level of fluid milk quota prices, and the industrial milk price is much lower than the fluid milk price. The exception is for the milk producers in Ontario, where a maximum of 75% of total quota holdings can be fluid milk quota. This specific regulation might, in some cases, force some of the fluid milk producers in Ontario to consider the more expensive Unused MSQ. Alternatively, a possibility is to buy Used MSQ as a long-run investment and pay the over-quota levy for the excess production that year.

Figure 3.2: Real Substitution Possibilities Between the Three Quota Types



3.4 Market Restrictions

There are several deviations from a perfect market in the quota exchange system. Since the milk marketing boards as institutions have objectives other than profit maximization, this has influenced the regulation of the organization. Most provinces have a "new-entry program" for farmers who want to start up dairy production. To obtain quota for this purpose, an assessment tax has been applied on all quota put out for sale. The tax is quantitative, and the tax amount is deducted by the Milk Marketing Board before the rest of the quota is offered on the quota exchange. The tax will only be levied on successful sales, and the rate has varied between 5 and 15 percent.

It has been remarked earlier (i.e. Barichello and Dunlop, 1987) that the quota exchange market sometimes can be a "thin market". If a major dairy producer in a province suddenly decides to go out of business, this may affect the size of the market substantially in the month of the quota sale. For example, a milk quota of 240,000 liters, equivalent to 44 milking cows with an average yield[9] of 5,459 liters per cow per year, will count for between 5% and 15% of the fluid quota market in Ontario for a given month. Decisions made by individuals might therefore affect the quota market substantially, and will therefore have the potential to affect the variation of the observed quota prices in the short-run. Producers however, can chose to sell off their quota gradually and therefore avoid disturbances in the quota markets.

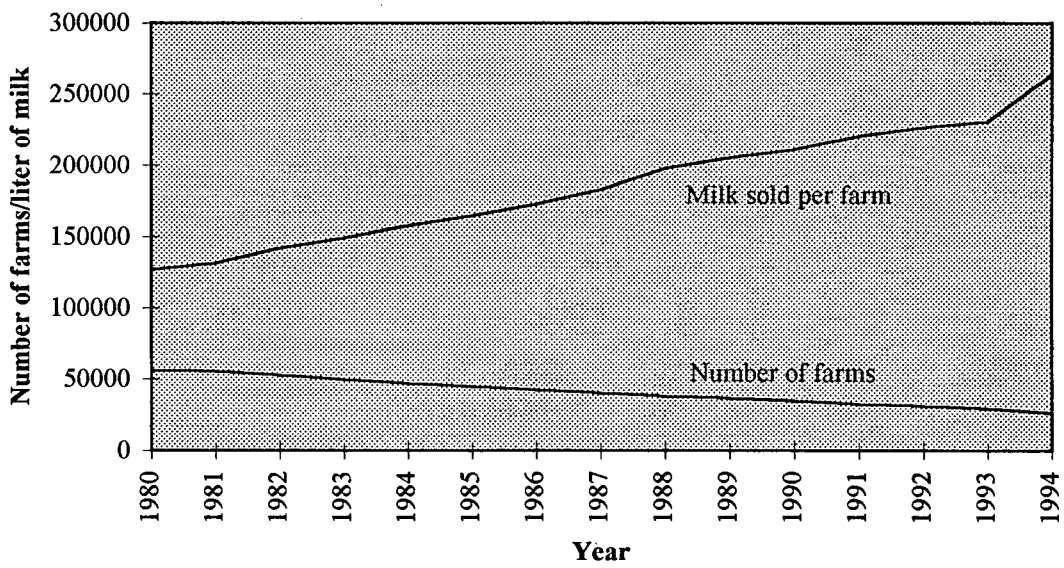
3.5 Production Efficiency

Canadian dairy production has gone through significant changes the last 15 years. Following, and contributing to the current pattern in the Western world, adaptation of new

[9] Estimated milk sold per dairy cow in Ontario in 1991/92. Source: Dairy Statistical Handbook.

technology on the production side, higher yield per cow, and external demand of a more efficient production, have increased the competition between farmers. Figure 3.3 illustrates this process in the time period from 1980 to 1994.

Figure 3.3: Average Volume of Milk Sold per Farm/Number of Farms in Canada, 1980 to 1994



Source: CDC and Statistics Canada

At the same time as the number of dairy farms has decreased, the average volume of milk produced per farm has increased. In other words, some farms have gone out of production, and the milk is now produced on units with higher production capacity. The increased average volume of milk sold per farm suggests a lower average cost of producing milk on the large farms. A decrease in production costs should therefore increase the real quota prices. How the net effect of such an impact can be measured, is more uncertain. But as an indicator of the

development in the structure of the Canadian dairy industry, the facts in Figure 3.3 can not be disputed.

3.6 Risk

3.6.1 Introduction

Risk, according to the capital asset pricing model, is separable into diversifiable and non-diversifiable risk (Neave and Witington, 1981). Diversifiable risk can be reduced to zero through diversification, whereas an asset's non-diversifiable risk remains, no matter how varied the wealth holder's mix of assets are, since there is some positive correlation across returns of most assets.

It is apparent how this distinction in standard finance theory between diversifiable and non-diversifiable risk, is relevant to the subject of valuing assets created by governmental regulation. Assets created by regulation can be destroyed, or their value eroded, by political action. Therefore, the anticipated profit will depend upon the vicissitudes of the political market place. It is not obvious, however, how such vicissitudes vary with the performance of the economy and the market for other assets.

3.6.2 The Presence of Risk

Appendix 2 gives a short summary of political events with importance for the future of the supply management system. If we for now ignore the time period prior to 1986, six major political events can be identified that may have affected quota prices: (1) September 1985: Canada and U.S. plan to seek a trade agreement; (2) The Uruguay Round of GATT launched in September 15, 1986, in which supply management was first discussed; (3) October, 1987: the

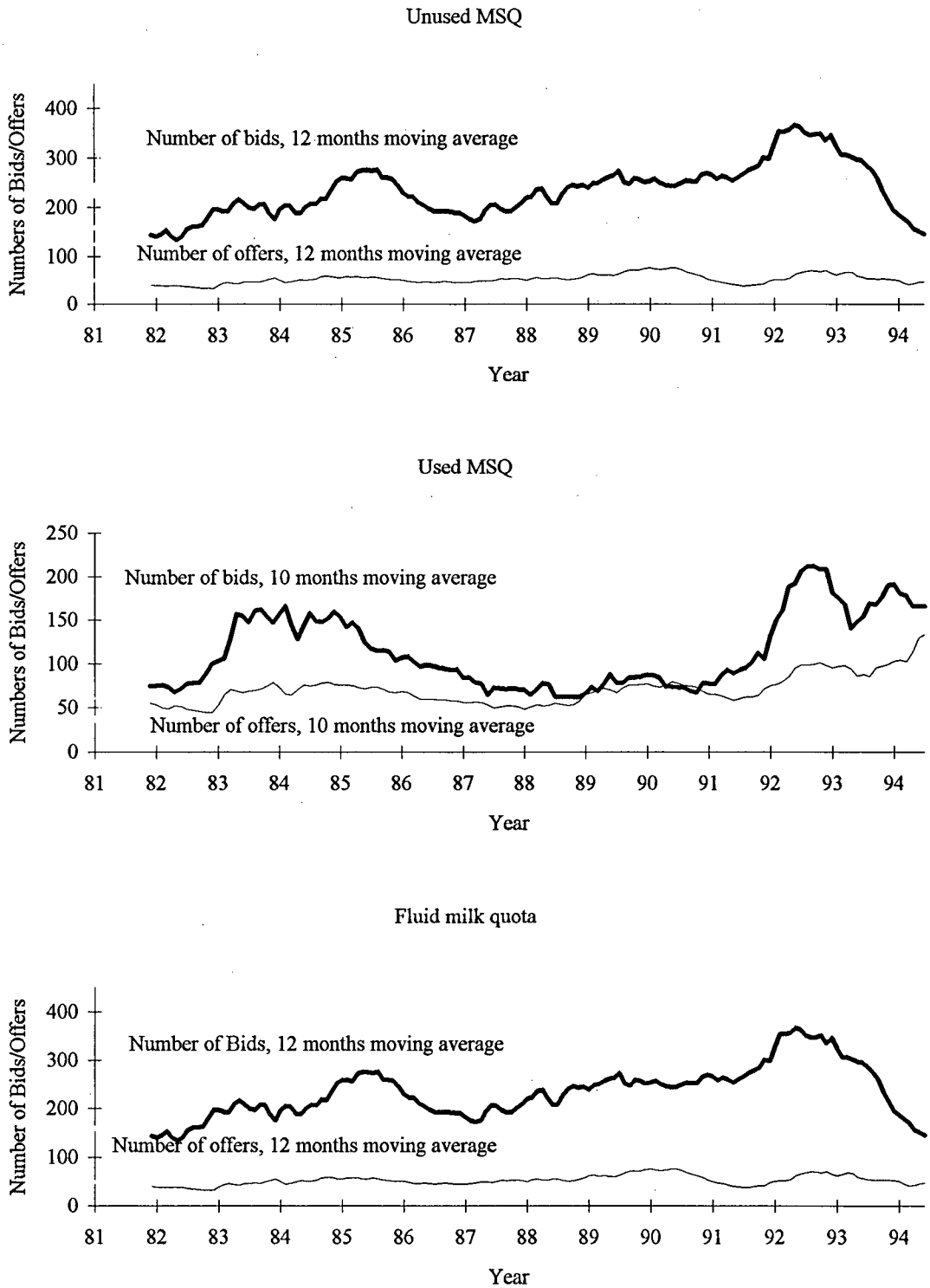
NAFTA agreement was reached; (4) January 18, 1988: ice cream, yogurt and other dairy products were added to the Import Control List, which reflected efforts by the Government of Canada to indicate its commitments to protect the dairy industry; (5) December 20, 1991: the Dunkel proposal was made public; and (6) December, 1993: the final agreement of the Uruguay Round of GATT was reached.

But even if we are aware of the economic and political history of Canada of interest to variation of milk quotas, it is not clear how this information influenced milk quota prices. There are two main difficulties in the process of measuring risk in this regard. First, we don't know how much a specific incident potentially influenced quota prices, and second, we have no clear indicator of when and how long the influence from, for example, a trade negotiation had an effect on milk quota prices. Some information might influence quota prices for a few months, while other information might have an impact for a longer period of time. Due to this uncertainty about how to measure political risk, it is appropriate to look for alternative or complementary information that potentially could be used as a second best approach.

3.6.3 The Quota Exchange Market

Figure 3.4 illustrates the number of bids and offers in Ontario between January 1981 and July 1994. The numbers of bids and offers follow a seasonal pattern, mainly due to the organization of the milk quota markets. There will for example hardly be any supply of Used MSQ in early fall, since milk producers will have utilized little of their quota yet, and the demand and supply for Unused MSQ normally increases at the end of the dairy year, when producers total milk production and total quota amount should be in balance. This seasonal issues are

Figure 3.4: Number of Bids/Offers in Ontario, January 1981-July 1994



Source DFO

important, but they are not the main focus here. To "screen" the data series in Figure 3.4 for seasonal effects, a 10[10] or 12 months moving average back in time is calculated.

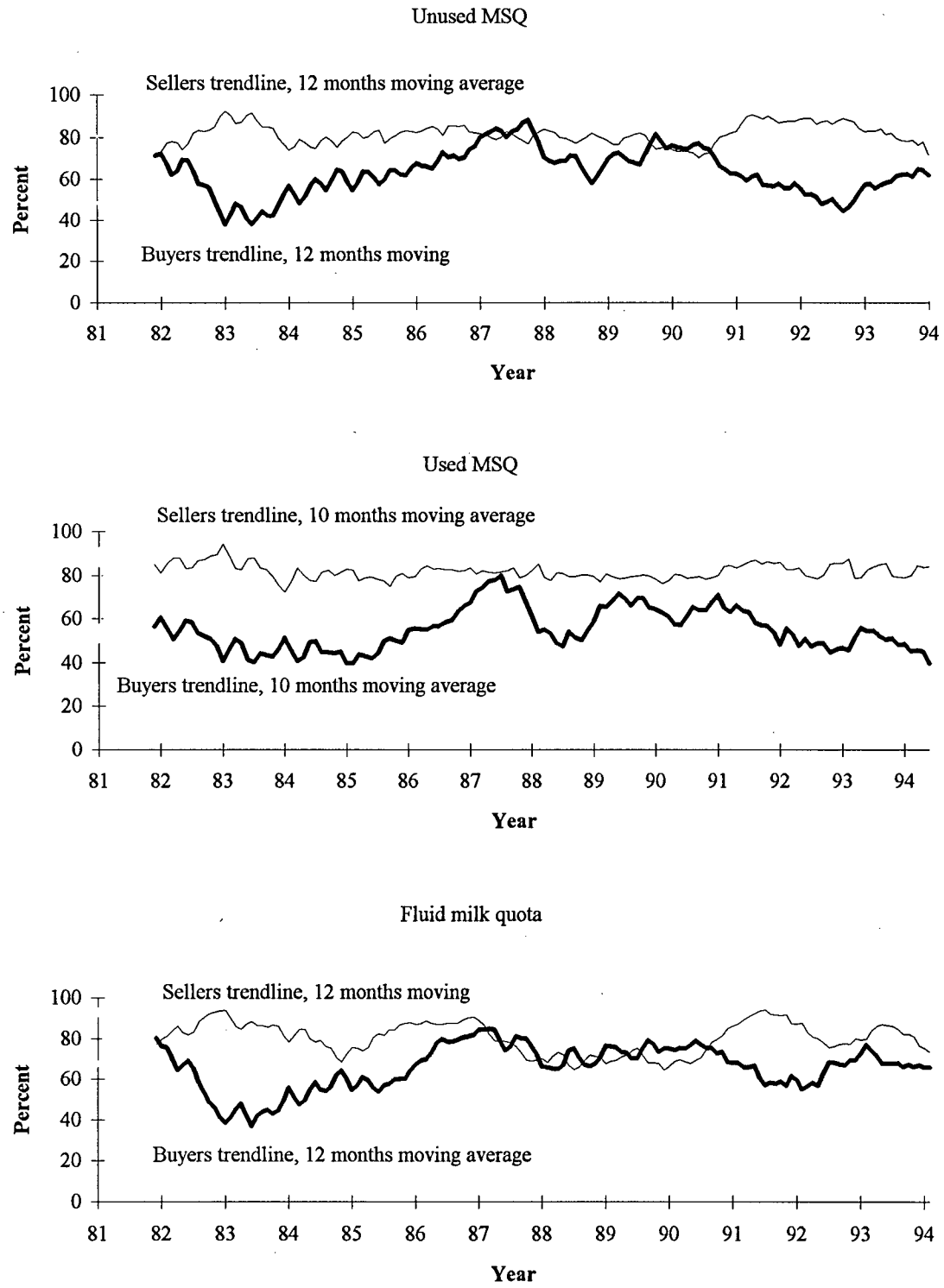
While the number of offers seems to follow a stable pattern, at least for Unused MSQ and fluid milk quota, a larger variation can be observed in the number of bids. The question is, if this variation in number of bids can be correlated with the perception of political risk, would there be fewer bids in times with high political uncertainty? It is natural to assume that potential quota buyers will be more careful entering the quota exchange market under these conditions, but we can also argue that the number of bids is not a very precise measurement for political risk. First, the lower the equilibrium quota price goes, the faster it is possible to pay off the quota investment. Second, quota holders might receive some sort of compensation if the supply management system is abandoned. It can therefore be argued that entering the quota exchange market with a "minimum" bid, even when the political risk is high, possibly is a rational behavior. The excess demand in Figure 3.4 illustrates that a large percentage of the bidders have lower bids than the equilibrium price. We do not have any data on the distribution of the bids, and a large share of the bids might be concentrated at a low price level. For the further investigation of the potential of this variable, we will therefore focus on the number of successful bids and offers, rather than the total numbers.

3.6.4 Success Rates

Figure 3.5 presents the percentage of bids and offers that were successful in Ontario for all three quota types during the auction processes. The figures show trend lines based upon a ten or twelve month moving average back in time. In other words, any given point on the trend lines is affected by all the observations in the previous year. Regardless of what incentives milk

[10] Since there is no trade with Used MSQ in August and September, there are only 10 exchanges a year.

Figure 3.5: Bid/Offer Success Rates in Ontario, January 1981- July 1994



Source DFO

producers have to offer quota for sale, they will face less long-run political uncertainty than quota bidders, since they are able to exit the market and sell the offered quota amount by the next month, if the offered reservation price is low enough. Therefore, unless the risk for a total abandonment of the quota regime is overwhelming, quota sellers may be less likely to sell off their quota due to political risk. The sellers in all quota markets seem to be very successful with their offers, with a high average success rate. The variation in these data is also much less volatile than in the data for the buyers success rate.

Why is the situation different for the quota buyers? Quota buyers are more concerned about getting both short- and long-run revenue from their investment, since the future net profit of holding quota is dependent on the continuation of the supply management regime. The variation in the bidders success rates are therefore more likely to capture the presence of political risk, where a low success rate would indicate low political risk, and a high success rate would indicate high political risk. This statement is built on two arguments, first, higher political risk means fewer number of bidders, and therefore a higher success rate. This situation can be seen in Figure 3.4, were a lower number of bids can be observed when the CUSTA and GATT negotiations took place. Second, since there is a situation with excess demand for quota, and therefore a sellers market, a higher political risk means that quota holders lower their reservation price, and thereby increase the bidders success rates.

By focusing on the buyers trendlines for Ontario in Figure 3.5, it is remarkable to see that the buyer success rates appear to follow an inverse pattern compared to the observed milk quota prices in Figure 1.1. The time range between 1987 and 1991 provides the highest buyer success rates, presumably, the time period where most of the political incidents of interest to the dairy sector took place (please see Appendix 2). Two periods of time attract special attention of

bidder success rates in Figure 3.5. The first, located between 1987 and 1988, is influenced by the launching of the new GATT negotiations, and the most intensive part of the CUSTA negotiations. The second, close to 1990, is influenced by the negative ice-cream/yogurt ruling and the ongoing GATT negotiations, introducing for example a proposal of a price cap on industrial milk. Both time periods show high succeeding rates.

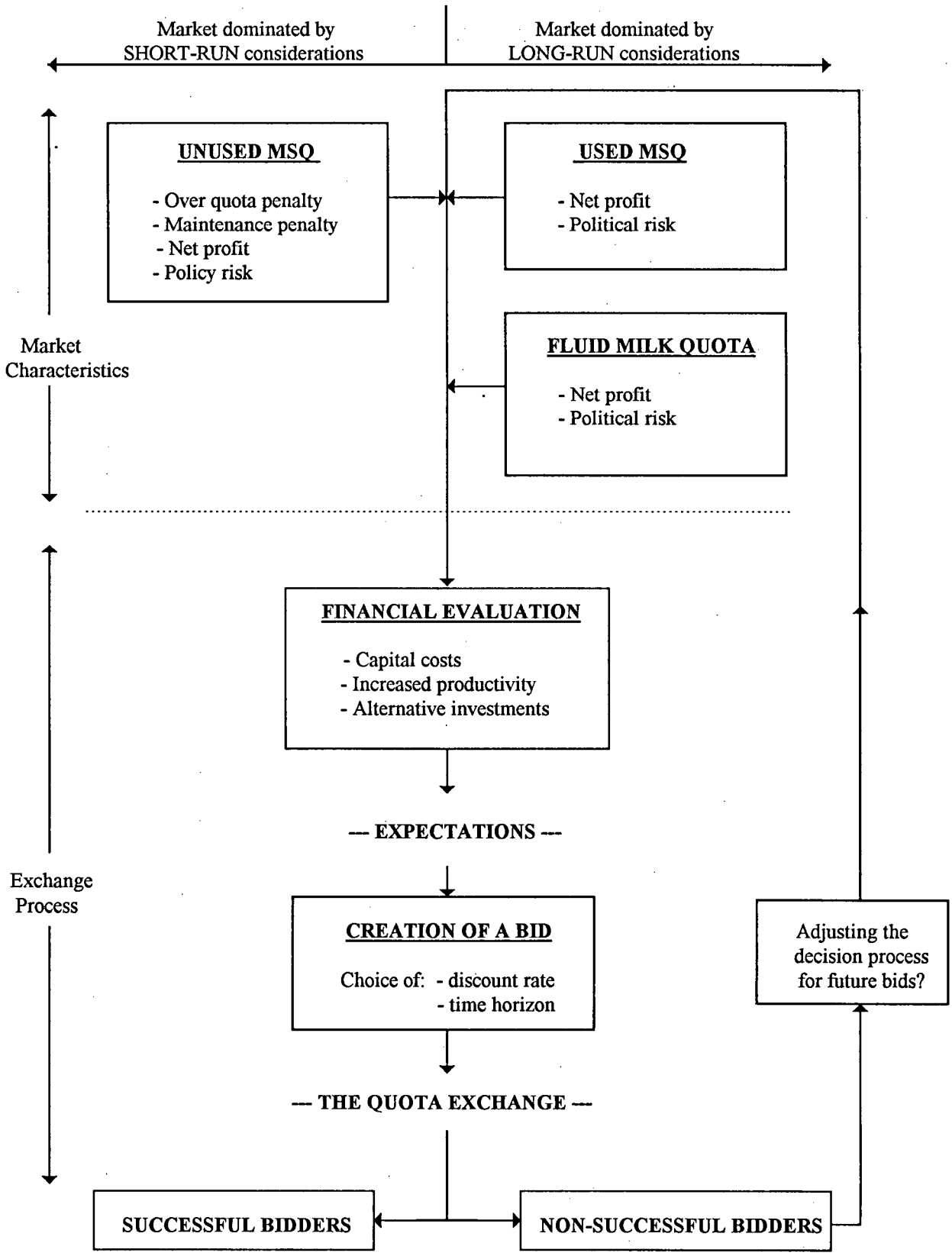
An interesting analysis remains, and we will investigate the indications on increased political risk, and utilize the data in an empirical model.

3.7 Theoretical Model

3.7.1 Introduction

The dairy producers face the same main problem as actors in all other production systems; limited knowledge of future information. The producer will ask how the present information can be transformed to a bid price on the quota market. The answer to this question can partly be given with producers *expectations* of the future. The expectations of future net profit and the expectations of political risk are both examples of considerations dairy producers have to make before quota is purchased. The overview of the quota market in Figure 3.6 makes it clear that a number of factors grouped under market characteristics, and the exchange process, will influence the formation of quota prices. Some of these factors are relatively easy to predict and do not change very much between months or even years, though, stability can never be guaranteed. A good forecast of the future value of these easily predictable factors, is found by using the last numeric observation available. By using naive expectations (Ezekiel, 1938), this month's level of the factor will be assumed to be the same as last month's level.

Figure 3.6: An Overview of the Quota Market; Characteristics and Operational Issues



Other factors are a lot harder to predict, since the level and growth of these factors are dependent on political decisions, international agreements and world market prices. How expectations of these factors should be treated, are more controversial and uncertain. Nerlove's (1958) work on adaptive expectations assumes that through an error-learning approach, consistent mistakes made in the past are partly corrected when future expectations are created. Much controversy exists around the hypothesis of adaptive expectations. The critics (McNees 1979) claim that the hypothesis of adaptive expectations is inadequate, because it relies solely on the past values of a variable in formulating expectations. Nevertheless, good arguments can also be put forward for why such a model is suitable in explaining the formation of quota prices. First, if dairy farmers at all time had full information about the market, then a non-error learning approach would have made sense. But since there are no possibility to be fully informed about the latest trends in the market, except last months quota price observations, this is a good argument for using an adaptive expectation framework when explaining milk quota prices.

Second, it is very hard to know exactly when new information is released to, learned by, or believed by the dairy producers. Sometimes we know the time when a change was executed, but what is most important is to know when this information was recognized or anticipated among the dairy producers. This might be several months before the dates of actual announcements in some cases, or months after introduction in other cases. The time aspect is therefore very uncertain for when information is made available, and this removes the basis for some of the criticism of the adaptive expectation model, since lack of complete information forces the dairy producers to partly rely on information from the past. Finally, in spite of some controversy, the model of adaptive expectations has been widely used to explain price formation within the area of agricultural production systems, and extensive literature of applications exist.

3.7.2 Basic Elements in a Capitalization Model

Consider a farm producing the output y according to a concave production function $y = f(x)$ where x denotes the input vector. A basic result of the duality approach to microeconomic theory (Varian 1990) is, that under cost minimization behavior, the cost function $c(y,w)$ represents an alternative description of this production technology, where the cost function is defined as:

$$c(y,w) = \min_{x} (wx : y <= f(x)) \tag{3.1}$$

with w being the input price vector. The supply response of the farm can be derived by extending the behavioral assumptions to profit maximization. Given an output price p, the profit function $\pi(p,w)$ is defined as:

$$\pi(p, w) = \max_{y} (py - c(y, w)) \tag{3.2}$$

The supply function $y(p,w)$ is immediately obtained from the profit function by Hotelling's lemma:

$$y = \partial\pi/\partial p \equiv y(p, w) \tag{3.3}$$

If we assume that quotas can be freely traded among producers, we can also assume that quotas can be rented at a price q (in other words, paying q gives the producer the right to produce one unit of y per one production period). Then the profit function in equation (3.2) can be amended to:

$$\pi(p-q, w) = \max_{y} ((p-q)y - c(y, w)) \tag{3.4}$$

The first-order condition for equation (3.2) requires:

$$p - q = \partial c / \partial y \tag{3.5}$$

which illustrates that the quota rental price q, at the optimal solution, equals the difference between price and marginal cost. It might be possible to transfer this information into a simple asset pricing model formula by using:

$$P_Q = \sum_{t=1}^{n} \frac{q}{(1+r)^t} \tag{3.6}$$

where quota price equals the present value of expected future rents discounted by a certain discount rate, r. The problem is that the rental price q, is typically not observed, as quotas in this industry are traded as capital assets that give the holder the right to produce indefinitely.

3.7.3 An Adaptive Expectation Model

A dynamic regression equation for quota values is postulated, as follows:

$$Y_t = \beta_0 + \beta_1 X_t^* + \sum_{k=1}^{n} \delta_k V_{k,t} + \varepsilon_t \tag{3.7}$$

where Y_t is the dependent variable for which explanation is sought, X^*_t and $V_{k,t}$ are explanatory forces, and ε_t is stochastic disturbance. Equation (3.7) postulates that Y_t is a function of expected values of X^*_t. Also, suppose there is influence on Y_t from other explanatory variables, so if a number, k, of these variables exists, we can denote the vector as, $V_{k,t}$

Since the expectation variable X^*_t. is not directly observable, it is necessary to formulate a hypothesis about how expectations are formed. One of the most popular models which is used to estimate response to changing expectations, where expectations change subjectively, is

$$X_t^* - X_{t-1}^* = (1-\lambda)(X_t - X_{t-1}^*) \tag{3.8}$$

or equivalently,

$$X_t^* = (1-\lambda)\left(X_{t-1} + \lambda X_{t-2} + \lambda^2 X_{t-3} + \ldots\right) \tag{3.8a}$$

where λ, such that 0 < λ < 1, is known as the coefficient of expectation. Hypothesis (3.8) and (3.8a) is known as the adaptive expectation (AE), or error learning hypothesis, first postulated by Nerlove (1958), and implies that the participants in the market will adapt their expectations in the light of past experience, and that, in particular, they will learn from their mistakes. More specifically, (3.8) states that expectations are revised each period by a fraction λ of the gap between the current value of the variable and its previous expected value. The AE model presented in (3.8) has been applied to numerous practical problems, given its appealing simplicity (Asskari and Cummings, 1977).

The practical problem with the postulated AE hypothesis, is how to do a correct estimation. The model could be simplified by the commonly used Koyck transformation. By substituting (3.8a) into (3.7), lag the result one period, multiplying by λ, and subtract the result from the original equation, we obtain

$$Y_t = \alpha(1-\lambda) + \beta(1-\lambda)X_t + \lambda Y_{t-1} + \sum_{k=1}^{n} \delta_k \left(V_{k,t} - \lambda V_{k,t-1}\right) + \eta_t \tag{3.9}$$

where $\eta_t = \varepsilon_t - \lambda\varepsilon_{t-1}$. But, unfortunately, when considering (3.9), there is no way to estimate the $(V_{k,t} - \lambda V_{k,t-1})$ term, so further pursuance of this method does not seem fruitful.

An alternative estimation procedure has been developed by Dhrymes (1971). By using a lag-operator as thoroughly described in Appendix 3, the AE hypothesis can be reformulated as

$$X_t^* = \frac{(1-\lambda)}{(1-\lambda L)} X_t \tag{3.10}$$

where L is the lag operator, defined for any variable, for example, Z, such that $Z_{t-i} \equiv L^j Z_t$. Substituting (3.10) into (3.7) gives

$$Y_t = \beta_0(1-\lambda) + \beta_1(1-\lambda)X_t + \lambda Y_{t-1} + \sum_{k=1}^{n} \delta_k V_{k,t} + \eta_t \qquad (3.11)$$

where $\eta_t = \varepsilon_t - \lambda\varepsilon_{t-1}$. The model in (3.11) can explain the formation of Y_t with adaptive expectations on X, in addition, a vector of several variables with naive expectations, $V_{k,t}$, can be used in the model, but without being geometrically distributed. In this case, experience from past observations will still be relevant, but these variables will not be perceived with an error learning approach. In (3.11), λ measures the average response of Y to a unit change in X^*_t, and the equilibrium or long-run value of X. $\beta_1(1-\lambda)$ measures the short-run impact multiplier. Once an estimate of λ is obtained from the coefficient of lagged Y, we can easily compute β_1 by simply dividing the coefficient of X_t by $(1-\lambda)$.

3.7.4 Summary

It is revealed and discussed in this section that *expectations* about the possibilities for future profit from holding production quota is important when we want to explain how milk quota prices are formed. However, how these expectations should be treated in a model is more uncertain. Due to the organizing of the milk quota exchange and how information is spread among the dairy producers, are there good reasons to partly rely on information from the past when explaining the formation of milk quota prices. This could be done with an adaptive expectation framework, as described in the previous section.

CHAPTER 4

4. EMPIRICAL IMPLEMENTATION

4.1 Potential variables

When explaining the formation of milk quota prices, the theoretical model in Equation 3.11 allows adaptive expectations on one variable, while several other variables can be included without having adaptive expectations. From the capitalization formula in Equation 3.6, the annual net profit from producing milk, and the discount factor are revealed as the basis elements in an asset pricing model. But after the previous analysis in Chapter 2 and 3, we might also suspect that a number of institutional regulations influences the formation of milk quota prices. This chapter will focus on the net profit from producing milk and the discount factor, and how to get reliable data that can be used in an empirical model.

4.1.1 A Direct Measurement of Net Profit

The definition and estimation of net profit is critical to successfully explain quota price formation. Because of the uncertainty in measuring the marginal cost of production and no possibility to observe quota rental rates in the milk quota markets, a second best measurement can alternatively be applied. As already mentioned in the literature review, one method of measuring direct net profit is to determine the price difference between the two industrial milk quota types. This approach has, for example, been used by Barichello (1984) and Meilke and Chen (1995). Here the present value of Used MSQ is:

$$V_{used} = R/(1+r) + R/(1+r)^2 + \ldots\ldots + R/(1+r)^n = R * S \qquad (4.1)$$

where $S = [1-1/(1+r)^n][1/r]$.

while the value of Unused MSQ is:

$$V_{unused} = R + R/(1+r) + R/(1+r)^2 + ... + R/(1+r)^n = R + R * S \qquad (4.2)$$

If we assumes that quota markets are working well, then the difference in observed quota prices between Unused MSQ and Used MSQ will reflect the net profit from holding MSQ. This can be expressed as

$$R_{MSQ} = V_{unused} - V_{used} \qquad (4.3)$$

On the other hand, we also know that the net profit at the margin of production must equal the price of milk minus marginal cost of production

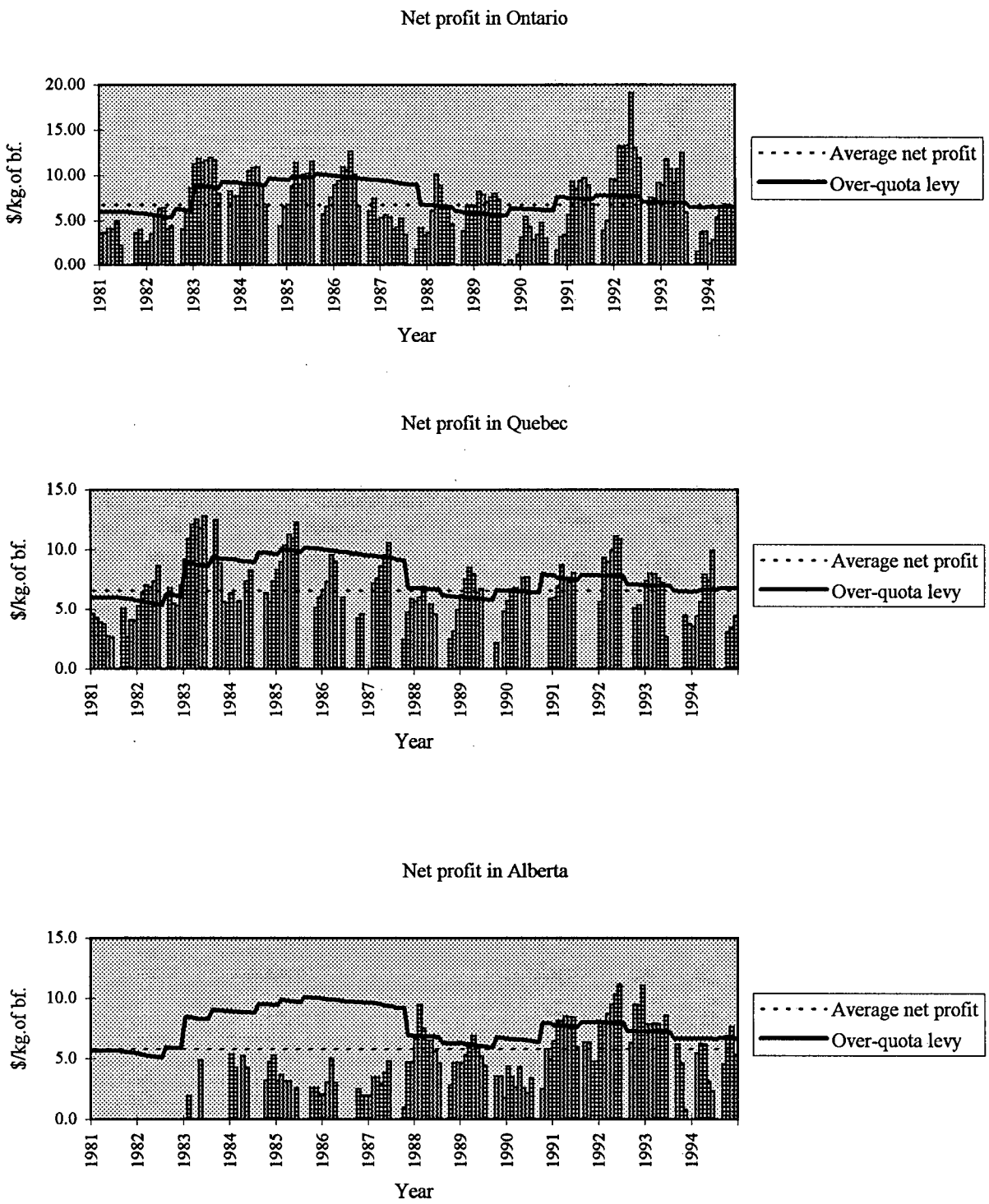
$$V_{unused} - V_{used} = Price\ of\ milk_{MSQ} - Marginal\ costs\ of\ production.$$

Finally, when assuming the same marginal costs for both industrial and fluid milk production, it is possible to use the information from the industrial milk quota market to estimate the net profit, R, for fluid milk, where

$$R_{FLUID} = (Price\ of\ milk_{FLUID} - Price\ of\ milk_{MSQ}) + R_{MSQ} \qquad (4.4)$$

Figure 4.1 presents the estimated real net profits in the industrial market for Ontario, Quebec, and Alberta when using the difference between Unused and Used MSQ (4.3) as the measure of yearly net profit. The Ontario data series presents an average of 6.74 $/kg of butterfat as the yearly net profit from holding industrial milk quota. The Quebec data shows a similar average net profit of 6.6 $/kg of butterfat, while Alberta has had a net profit of 5.8

Figure 4.1: Estimated Real Net Profit from Holding MSQ in Ontario, Quebec, and Alberta



$/kg of butterfat since 1988[11]. Even if the average numbers present reasonable results, there are large variations in the estimates. Two trends can be observed in the figure. First, there is substantial variation within the dairy year, and second, the level of estimates varies from year to year. Quota management issues can explain the increased willingness to increase quota bids in the last part of the trading season for Unused MSQ, and therefore some of the seasonal variation in MSQ prices. The latter variation might be induced by the perception of political risk for the future of the quota regime. However, since quota management issues to meet this years quota requirements are short-run considerations, and will be incorporated in Unused MSQ prices, short-run influences will also be included in this measurement of net profit. It is therefore possible that the estimation of net profit after method (4.3), presented in Figure 4.1, is sometimes biased upwards due to the importance of these short-run considerations.

The interpretation of the estimation of net profits in fluid milk production (4.4) is even more challenging. First, if there is a danger for over-biased estimates of net profits in the industrial milk market, this error will also influence the calculation of net profits estimates for fluid milk. Second, the assumption of equal marginal cost of production in the two milk markets must be correct. Initially, since raw milk is a homogenous good delivered from the farm, the assumption of equal marginal cost of production seems reasonable. But it can be argued that cost of production is higher in fluid milk production than in industrial milk production. Daily delivery of fluid quota is more demanding, hence costly, since milk production has to be stable throughout the year. Fluid milk producers can therefore not take the same advantage of the less costly summer feeding in proportion as industrial milk producers. A net profit estimation from holding fluid milk quota, as described in Equation 4.4,

[11] Since Alberta first started their quota exchange of industrial milk quota in 1983, and the activity on this market proved very thin in the first years, there is a good reasons not to emphasize this period to much.

might therefore induce higher estimates of net profit from holding fluid milk quota than the true net profit.

An interesting observation is the level of the over-quota levy in Figure 4.1. In retrospect, it seems like the dairy farmers who bought Unused MSQ when the level of estimated net profit exceeded the over-quota penalty, lost money, since they would have been better off paying the over-quota levy and buying Used MSQ. Why this occurs is a puzzle, and might indicate that we are missing some necessary knowledge about quota markets.

4.1.2 An Indirect Measurement of Net Return; Milk Prices

Due to the possible incomplete capture of long-run considerations when estimating net returns using equations (4.3) and (4.4), it might be appropriate to introduce the milk price as a potential variable to capture the expectations of net profit in the long-run. The milk price received by the dairy farmers, minus the cost of production, determines the annual net profit on the produced milk, and both these variables are therefore crucial for the explanation of milk quota prices. Unfortunately, there is no measurement of how production costs have changed over time.

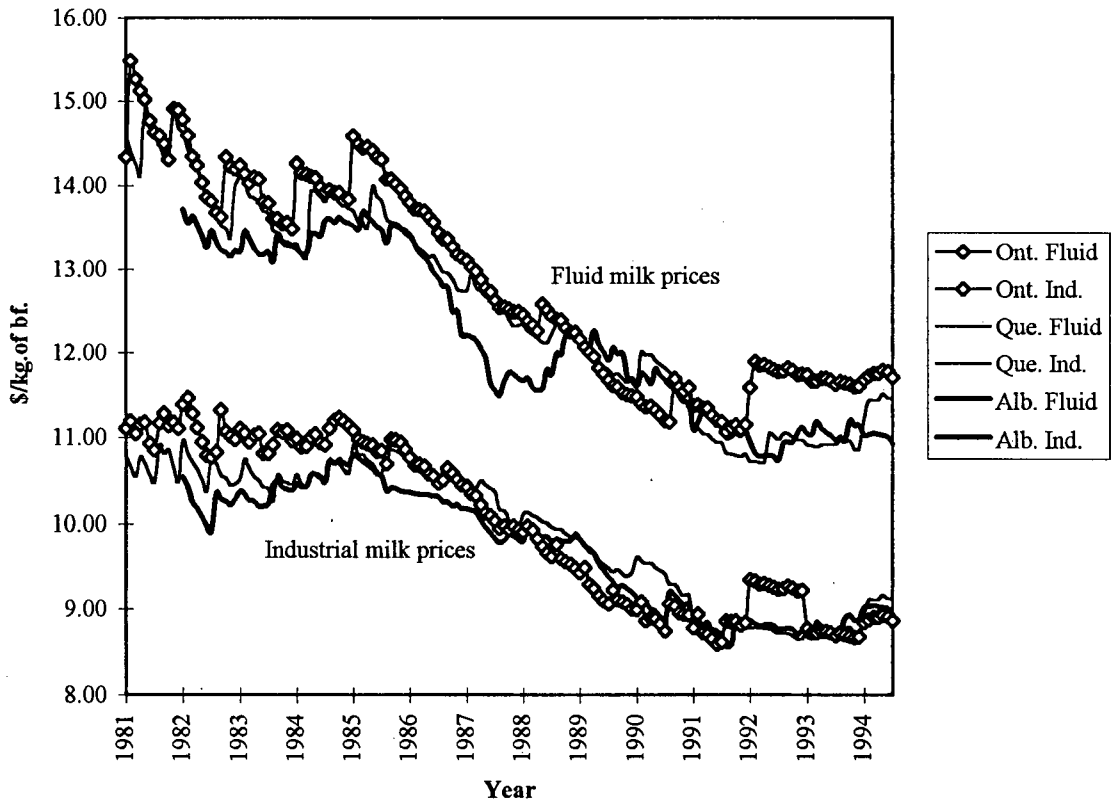
In Figure 4.2 the real monthly milk prices are plotted for Ontario, Quebec, and Alberta. The fluid milk price is the average of monthly class 1 prices, net of transportation costs and MMB fees, while the industrial milk price is the average of monthly blend prices (classes 3 to 6), net of transportation costs, MMB fees, in quota-levy, but inclusive of the federal direct subsidy. Note that fluid milk prices are always above the industrial milk prices. To compare prices before and after Ontario and Quebec implemented multiple component pricing (MCP)[12],

[12] Ontario started with MCP in January 1992, and Quebec in August 1992.

prices are converted to the old system by multiplying each component test with its price, and adding the milk differential. With a few exceptions, real milk prices have decreased between 1981 and 1995. Among these three provinces, on average Ontario seems to have the highest price level, followed by Quebec, and Alberta.

Since there is no obvious and exact way to measure production costs, no singular productivity variable will be included in the empirical model, other than what already is captured in the cost of production determined milk price formula.

Figure 4.2: Monthly Real Milk Prices in Ontario, Quebec, and Alberta

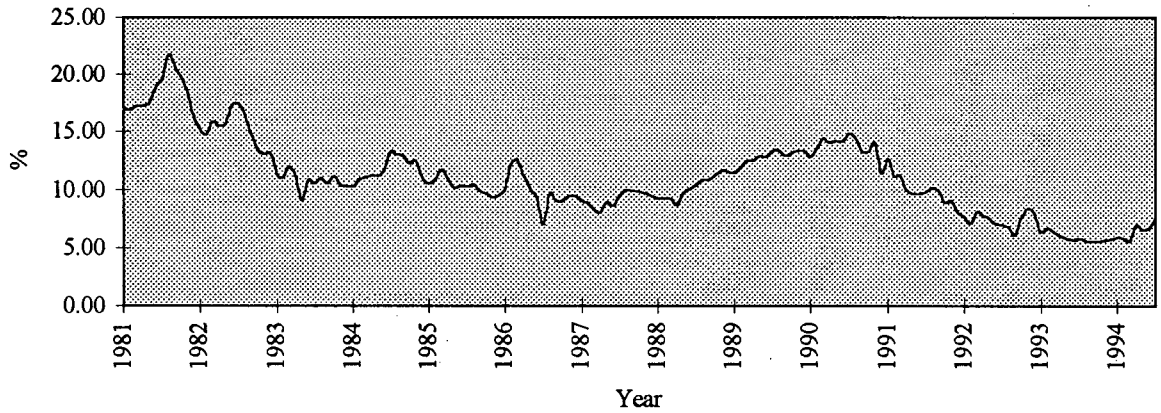


Source: Dairy Market Review

4.1.3 The Discount Rate

Arcus (1978); Barichello (1984); Lermer and Stanbury (1985); Moschini and Meilke (1988); and Meilke and Chen (1995) all conclude that the discount rate in a milk quota capitalization model is higher than in most other non-quota markets. Following the work of Beck, Hoskins and Mumay (1994), risk can be divided into a riskless part, a risk compensation part, and a policy risk compensation part. It might be appropriate to use the commercial loan rate in Figure 4.3 as a measurement to represent the riskless rate and the risk compensation in an empirical model.

Figure 4.3: Prime Business Loan Rate



Source: Bank of Canada/Statistics Canada

A significant part of the discount rate has normally been interpreted as compensation for the policy uncertainty involved in a quota purchase. A large policy risk premium can be expressed alternatively as quota buyers using a short time horizon for discounting the quotas future returns. Unfortunately, there is no standard with which to determine the size of the risk compensation, since risk is perceived differently among the participants in the quota exchange.

The presence of risk however, might be detected by using the bidders success rates for Ontario, described in detail in Chapter 3.5. Unfortunately, the same data have not been made available for Quebec and Alberta, and it is therefore not possible to use the same political risk variable when explaining the quota price formation in Quebec and Alberta. But when combining the information from Ontario with the history of political events (as described in Appendix 2), we have already detected that the time periods 1986 to 1988 and 1989 to 1991 were influenced by several proposals of changes in the current supply management system. It might therefore be possible to use this information when explaining the determination of quota prices.

4.2 Price Functions

The general price function for milk quota can be written as

$$P_Q = P_Q(x_1, \ldots, x_n)$$

where x_1 to x_n represent the explanatory factors for price determination. It is argued in Chapter 4.1, that the estimated net profit from Equations 4.3 and 4.4, together with the milk prices can be used to represent the expectations of annual net profit from holding milk quota. In the same chapter, it is also argued that the commercial interest rate and a policy risk variable can be tested in an empirical model as possible information sources of the discount factor in a capitalization model. From the analysis in Chapter 2 and 3, we know that some institutional factors can be binding, and therefore influences the formation of milk quota prices. Such factors can be the possibilities for substitution between quota types, the assessment tax, and the over-quota levy. The over-quota levy is probably binding only for MSQ prices.

Thus, the three following price functions for milk quota are hypothesized:

$$P_{UNUSED} = P_{UNUSED}(NP, MP_{IND}, r, PR, P_{FLUID,t-1}, OQL, A.Tax) \quad (4.5)$$

$$P_{USED} = P_{USED}(NP, MP_{IND}, r, PR, P_{FLUID,t-1}., OQL, A.Tax) \quad (4.6)$$

$$P_{FLUID} = P_{FLUID}(NP, MP_{FLUID}, r, PR, P_{USED,t-1},, A.Tax) \quad (4.7)$$

where

P_{UNUSED} = price of unused MSQ

P_{USED} = price of used MSQ

P_{FLUID} = price of fluid milk quota

NP = current yearly net profit from holding quota

MP_{IND} = milk price of industrial milk, a proxy for long-run net profit

MP_{FLUID} = milk price of fluid milk, a proxy for long-run net profit

r = the commercial interest rate (in percent)

PR = a proxy for policy risk

OQL = over-quota levy

$A.Tax$ = changes in the assessment tax.

4.3 Empirical Model

If we use the adaptive expectation framework described in Chapter 3.6, the price equation (4.5) for Unused MSQ can under these assumptions, be expressed as

$$P_{UNUSED} = \hat{\beta}_0(1-\lambda) + \hat{\beta}_1(1-\lambda)NP + \lambda P_{UNUSED,t-1} + \sum_{k=1}^{n} \hat{\delta}_k V_{k,t} + \eta_t \quad (4.8)$$

where $V_k = [MP_{IND}, r, P_{FLUID,t-1}, PR, OQL, A.Tax]$

and $k = [1,..,6]$

Two different types of expectations are hypothesized in Model 4.8. First, it is assumed that the quota buyers have adaptive expectations on the net profit variable (NP)[13]. Second, the other variables (V_k), are perceived with naive expectations. Naive expectations in this connection, simply means that the latest known value of a specific variable is used, assuming that this months level of the variable is the same as last months level. In other words, the expectations are naive in the way that past mistakes will not influence future expectations.

[13] An alternative could be to use adaptive expectations on the milk price variable (MP).

CHAPTER 5

5. DATA AND METHODOLOGY

5.1 Quota Price Data

Fluid milk quota, and Unused and Used MSQ prices in Ontario and Alberta, were obtained from the Dairy Farmers of Ontario (DFO) and the Alberta Dairy Control Board (ADCB), respectively. Fluid milk quota prices, and prices of Unused and Used MSQ in Quebec, were obtained from Agriculture Canada's Dairy Market Review and from Le federation des producteurs de lait, Quebec. In comparing these data, there are two complications. First, the Ontario Unused and Used MSQ prices were reported as $ per hectoliter before August 1990, and as $ per kilogram of butterfat after August 1990. The butterfat test used by DFO is a 12 month weighted average butterfat test. Unused and Used MSQ prices before August 1990 are therefore converted to $ per kilogram using the 12 month weighted average butterfat test. Second, fluid milk quota is a daily quota, measured in $ per kilogram. To make these prices comparable, daily fluid milk quota price is converted to annual price measured in $ per kilogram of butterfat, by using the following formula:

$$\text{Annual fluid milk quota price (\$/kg of butterfat)} = \frac{100 * \text{Daily fluid milk quota price (\$ per liter per day)}}{365 \text{ Days} * \text{12 month average butterfat test}}$$

The time period under consideration is August 1980 to December 1994. However, the total number of observations are different for each quota type, due to the numbers of months that the quota auction has been operated. There is no trade in MSQ in Quebec in August and September, while fluid milk quota is traded all year long. This is also the case for Ontario, except that Unused MSQ is traded throughout the whole year. In Alberta, trade in MSQ

started in October 1983 and trade in fluid milk quota started in August 1990. In Alberta, there is no trade in MSQ in July, August and September prior to 1988, and no trade in August and September after 1988.

From time to time, quota exchanges have been canceled due to various reasons such as no quota supply available. Hence the resulting number of observed quota prices as well as quota types, are not the same across provinces. Ontario provides the most complete data set for the three types of quota prices.

Consumer price index series (CPI) for major cites in Canada were collected from Statistics Canada. All quota prices were deflated by the CPI of the respective province with June 1986 = 100.

5.1.1 The Level and Variations of Quota Prices

Table 5.1 presents mean and standard deviation of monthly real prices of fluid milk quota, Unused MSQ and Used MSQ in Ontario from August 1980 to July 1994, and in Quebec from August 1980 to December 1994. Mean and standard deviation of monthly real prices of Unused MSQ and Used MSQ in Alberta from January 1983 to December 1994, and that of fluid milk quota from January 1990 to December 1994, are presented as well. Several observations regarding the level and volatility of fluid milk quota, Unused MSQ and Used MSQ prices can be made:

(1) In all provinces Unused MSQ prices are higher than fluid milk quota prices, and fluid milk quota prices are higher than Used quota prices. In Ontario, for example, the average Unused MSQ price is $20.56/kg of butterfat, the average fluid milk quota price is $16.33/kg of butterfat, and the average Used MSQ price is $14.41/kg of butterfat from August, 1980 to July

Table 5.1: Means and Standard Deviations of Monthly Quota Prices in Ontario, Quebec, and Alberta:

$/kg. of butterfat (constant $ 1986)

		Fluid Milk Quota			Unused MSQ			Used MSQ		
		Ontario	Quebec	Alberta	Ontario	Quebec	Alberta	Ontario	Quebec	Alberta
1980/81	Mean	10.01	15.23		13.20	13.00		10.21	8.43	
	St.dev.	*0.99*	*0.76*		*1.88*	*1.29*		*0.92*	*1.54*	
1981/82	Mean	9.61	14.85		11.98	16.38		8.43	10.63	
	St.dev.	*0.51*	*1.41*		*2.82*	*4.51*		*1.30*	*2.92*	
1982/83	Mean	14.53	20.43		22.21	25.97	5.87	14.33	16.58	2.11
	St.dev.	*2.10*	*3.13*		*6.49*	*5.58*	*4.10*	*3.32*	*2.75*	*4.67*
1983/84	Mean	17.34	21.01		24.63	21.06	6.57	16.99	16.34	2.17
	St.dev.	*1.18*	*0.97*		*3.83*	*2.80*	*0.77*	*1.99*	*4.06*	*0.87*
1984/85	Mean	18.84	25.13		26.25	24.55	7.17	18.64	15.50	3.39
	St.dev.	*2.23*	*1.28*		*11.78*	*3.62*	*0.90*	*2.35*	*1.48*	*1.50*
1985/86	Mean	20.28	25.97		26.54	25.50	8.58	18.63	18.86	6.08
	St.dev.	*0.32*	*1.52*		*3.79*	*9.59*	*1.11*	*1.71*	*1.46*	*0.49*
1986/87	Mean	18.88	25.71		21.51	25.64	11.81	16.22	18.45	8.83
	St.dev.	*2.06*	*1.09*		*1.24*	*3.97*	*2.92*	*0.84*	*2.19*	*2.06*
1987/88	Mean	16.93	24.55		19.22	24.35	17.80	14.09	19.04	12.06
	St.dev.	*1.10*	*1.60*		*3.57*	*1.05*	*2.04*	*1.86*	*1.53*	*1.98*
1988/89	Mean	16.16	22.13		18.19	22.59	13.90	11.97	16.83	8.85
	St.dev.	*0.80*	*1.17*		*2.27*	*2.30*	*0.68*	*0.79*	*0.66*	*1.16*
1989/90	Mean	13.98	21.12		12.51	20.61	9.52	9.45	15.28	6.35
	St.dev.	*1.02*	*0.30*		*1.81*	*2.60*	*1.73*	*0.72*	*0.90*	*1.88*
1990/91	Mean	15.72	21.67	13.77	16.49	23.66	13.78	10.47	18.07	7.05
	St.dev.	*1.10*	*0.55*	*1.13*	*5.28*	*3.15*	*4.29*	*2.43*	*1.21*	*3.22*
1991/92	Mean	18.44	24.58	15.49	23.64	28.38	15.43	13.94	19.83	7.64
	St.dev.	*1.19*	*1.67*	*0.88*	*7.08*	*2.61*	*2.37*	*3.18*	*1.80*	*0.66*
1992/93	Mean	19.65	28.90	17.51	27.31	29.09	21.16	18.66	23.27	12.82
	St.dev.	*0.69*	*1.21*	*0.74*	*4.76*	*2.70*	*4.75*	*3.41*	*1.57*	*5.16*
1993/94	Mean	18.19	26.96	16.22	24.15	28.49	18.01	19.75	22.95	14.83
	St.dev.	*2.26*	*3.01*	*2.12*	*3.72*	*3.84*	*3.24*	*2.71*	*2.27*	*1.12*
1994	Mean		26.35	15.12		26.91	19.46		23.15	13.35
	St.dev.		*1.77*	*0.27*		*0.44*	*1.43*		*0.81*	*1.29*
	Average	**16.33**	**22.97**	**15.62**	**20.56**	**23.75**	**14.89**	**14.41**	**17.55**	**10.42**
	St.dev.	***1.25***	***1.43***	***1.03***	***4.31***	***3.34***	***4.98***	***1.97***	***1.81***	***4.59***

1994. The average difference between Unused MSQ price and fluid milk quota price is $4.23/kg of butterfat calculated in the time period between August 1980 and July 1994. Such a large difference is striking given the fact that the fluid *milk* price is considerably higher than the

industrial milk price. The difference between Unused MSQ price and Used MSQ price is $6.15 per kg of butterfat from August, calculated in the time period between 1980 and July 1994.

(2) In all provinces Unused MSQ prices are more volatile than Used MSQ prices, and Used MSQ prices are much more volatile than fluid milk quota prices, as measured by the coefficients of variations. In Ontario, for example, the standard deviation is 4.31 for Unused MSQ prices, 1.97 for Used MSQ, and 1.25 for fluid milk quota price from August, 1980 to July 1994.

(3) For all three types of quotas, prices in Quebec are higher than in Ontario, and prices in Ontario are higher than in Alberta. The differences between Quebec and Ontario prices are relatively small (on average $3.19 per kg of butterfat for Unused MSQ), while the difference between Quebec and Alberta prices is rather large ($8.89 per kg of butterfat). Such regional differences in quota prices are normally attributed to the regional differences in marginal costs, but a substantial regional difference in marginal costs is needed to justify a quota price difference of $8.89 per kg of butterfat.

(4) In terms of volatility, Alberta Unused and Used MSQ prices are the most volatile, followed by the Ontario Unused and Used MSQ prices, and then by the Quebec Unused and Used MSQ prices. The standard deviation of the Alberta prices is almost double the standard deviation of prices in Ontario and Quebec.

Figures 1.1, 1.2, and 1.3 in Chapter 1.1, depict movements of monthly real prices of Unused MSQ, Used MSQ, and fluid milk quota in Ontario, Alberta, and Quebec, respectively. Prices of all three categories of quotas were rising quickly in Ontario and for fluid milk quota in Quebec in the early 1980's, and reached a peak in mid-1986, leveled off until the mid-1990s, and have increased since then. Except, as indicated, the fluid milk quota price decreased during

the period of 1992-93 and 1993-94. This may be due to the introduction of a pooled single quota system, established in August 1994.

5.2 Methodology

5.2.1 Maximum Likelihood Estimation

Several problems have occurred in the process of estimating the parameters of the geometrically distributed lag model as presented in equation (4.8). The model is relatively simple in its form. The trouble with this model is that the disturbance term η_t follows an autoregressive moving average (ARMA) pattern, and is correlated with Y_{t-1}, which is one of the explanatory variables. Furthermore, Y_{t-1} depends directly on η_{t-1}. Consequently the lagged dependent variable Y_{t-1}, which is a random regressor, is contemporaneously correlated with the error term η_t, which makes the least squares estimator of equation (4.8) both *biased* and *inconsistent*, since the bias does not disappear in large samples.

Consistent estimates of the coefficients can be obtained by using the Maximum Likelihood principle (ML). To be able to do this estimations, the quota prices models are transformed to a logarithmic likelihood function. Since we have no information about the net profit variable (NP), other than the sample values of NP_1, NP_2,..., NP_n, the maximum likelihood estimates of β_0, β_1, δ_k, and λ will be asymptotically efficient. Their asymptotic variances can be estimated by using the appropriate information matrix. The price function for Unused MSQ, (see Equation 4.5), can be written as

$$L = -\frac{n}{2}\log\left(2\pi\sigma^2\right) - \frac{1}{2\sigma^2}\sum_{t=1}^{n}\left[P_{UNUSED,t} - \hat{\beta}_0(1-\lambda) - \hat{\beta}_1(1-\lambda)NP_t - \lambda P_{UNUSED,t-1} - \sum_{k=1}^{n}\hat{\delta}_k V_{k,t}\right]^2 \tag{5.1}$$

where $V_k = [MP_{IND}, r, P_{FLUID,\,t-1}, PR, OQL, A.Tax]$

and $k = [1,.., 6]$

By using this maximum likelihood estimation, all the parameters can be estimated at the same time, and the auto correlation in the error terms are adjusted. The models for Used MSQ and fluid quota prices can be presented in a similar way by use of either price function (4.6) or (4.7).

5.2.2 Biased Results and Simultaneity

Since the net profit variable (NP) is defined as the difference between the price on Unused MSQ and the price on Used MSQ, the Unused quota price in Equation 5.1 is used both as a dependent and an independent variable, and this might imply biased results. But the estimated adaptive expectation coefficient, λ, will still be unbiased since the adaptive expectation model is estimated with a maximum likelihood procedure, where the results are unbiased and consistent. So if there are biased results, this will appear in the net profit coefficient.

An alternative method to avoid biased results, is to substitute the NP variable in Equation 5.1 with $[P_{UNUSED} - P_{USED}]$. The factored result can be written as

$$P_{UNUSED} = \frac{\hat{\beta}_0(1-\lambda)}{s} - \frac{\hat{\beta}_1(1-\lambda)}{s} P_{USED} + \frac{\lambda}{s} P_{UNUSED,\,t-1} + \frac{1}{s}\sum_{k=1}^{n} \hat{\delta}_k V_{k,t} + \frac{\eta_t}{s} \qquad (5.2)$$

where $s = [1-\beta_1(1-\lambda],$

$V_k = [MP_{IND}, r, P_{FLUID,\,t-1}, PR, OQL, A.Tax]$

and $k = [1,..,6]$

The Unused quota price in Model 5.2 is not explained directly by the proxy for net profit (NP), but with the price of the other MSQ type, Used MSQ.

Another potential problem is simultaneity. If there is a high degree of simultaneity between the dependent variable and the net profit variable, the parameters in the original model (5.1) can be calculated by using the estimated results from the revised model (Model 5.2).

5.2.3 Correlation

There are degrees of correlation between the variables in the proposed price functions (Equation 4.5-4.7). The correlation matrixes are listed in Appendix 4.2. A large variation in correlation coefficients can be observed. Most interesting, the correlation coefficients between the explanatory variables rarely exceeds 0.5.

5.2.4 Various Estimations

Based on the price functions for milk quotas seen in equation (4.5), (4.6), and (4.7), a variety of estimations will be presented for Ontario, Quebec, and Alberta. In the first set of results (Model 1a), the adaptive expectation coefficient λ is restricted to zero. This is done to see what happens when "naive" expectations are assumed on the net return variable, and no error learning process take place. In the second model (Model 1b), the data is transformed to logarithmic form, but estimated with the same model and the same variables as in Model 1a. The estimated coefficients in this model can therefore be interpreted in percentage terms as elasticities. The third set of results (Model 2a) are obtained from the adaptive expectation model, by use of the maximum likelihood framework in equation (5.1). The data used in this model is also in logarithmic form. The last set of results (Model 2b) is included, such that an

indicator of the degree of simultaneity in the estimation of the adaptive expectation model can be found. As described in Chapter 5.2.2, this might be a problem due to the definition of the proxy for net profit, NP. Also, this logarithmic factored model is only estimated for Unused and Used MSQ.

For Ontario, the bidders success rate will be used as a measurement of political risk, while for Quebec and Alberta, the time dummy variables CUSTA and GATT represent the increased political risk during these trade negotiations. The CUSTA variable is defined from July 1986 to June 1987, and the GATT variable from January 1989 to December 1990.

An assessment tax increase should theoretically increase the quota prices, but only the province of Quebec changed the tax level during the time period under considerations in this thesis, with a tax increase of 5% both in June 1986 and September 1992. To test if these two tax increases had a significant effect on the level of milk quota prices two time dummy variables are created, one for the post-time period of each tax increase.

5.2.5 Practical Considerations

Models 1a and 1b are estimated by adapting an ordinary least square approach with auto regressive error terms. All estimations of the adaptive expectation models 2a and 2b are carried out by following the Beach-MacKinnon (1978) estimation procedure in the econometric software SHAZAM. Here, the first step is to maximize the log-likelihood function with respect to β holding λ fixed (initially $\lambda = 0$) and then maximizing L with respect to λ, considering β fixed. The solutions to these maximization problems are developed in Beach and MacKinnon. The estimation is iterated until two successive estimates of λ differ by less than 0.001.

To obtain reliable and unbiased results, it is necessary to delete some of the observations, because some of the rows in the information matrix include zero's, and substantially increase the variation of the time-series observations. As earlier explained, the reason for this is the cancellation of the quota exchange during certain months. The number of observations used during the estimations are therefore not the same across quota types and provinces. In Alberta, this means that only observations after 1991/92 are used. The political risk variable is therefore left out in the Alberta estimations, since most of the uncertainty about the future of the current supply management regime took place before 1991/92.

The Durbin-Watson d statistics may not be used to detect first-order serial correlation in autoregressive models, because the computed d value in such models generally tends towards 2, which is the value of d expected in a truly random sequence. However, Durbin (1970) proposed a large-sample test of first-order serial correlation in a autoregressive model. This test, called the h-statistic, is as follows

$$h = \hat{p}\sqrt{\frac{N}{1 - N\left[\operatorname{var}\left(\hat{\lambda}\right)\right]}}$$

where $\hat{p}$ = estimate of the first-order serial correlation p, which is given by $\frac{\sum e_t e_{t-1}}{\sum e_t^2}$, N is the sample size, and $var\ \hat{\lambda}$ = variance of the lagged dependent variable. It was detected during the estimation procedure, that some of the estimation models had Durbin-h values exceeding the interval [-1.96, 1.96] and therefore provided evidence of second-order auto-correlation (AR2) disturbances in the error terms. SHAZAM's Maximum Likelihood Procedure adapts to this difficulty by setting ORDER=2 in the estimation loop. No evidence of higher auto-correlation

orders were detected. Estimated correlation matrixes for each province are listed in Appendix 4.

A problem in some of the model estimations is that the constant terms are insignificant. This is a sign of a specification error in the estimated model, as compared to the true model. In other words, an irrelevant variable is probably included. The consequences of such a specification error are, in addition to insignificant constant terms, as follows:

1. The estimators of the "incorrect" model are all unbiased and consistent, that is $E\left(\hat{\beta}_0\right) = \beta_0$,

   $E\left(\hat{\beta}_1\right) = \beta_1$, ... = 0,

2. The error variance σ^2 is correctly estimated, and
3. The usual confidence interval and hypothesis testing procedures remain valid.

Therefore, it can be concluded that the inclusion of the superfluous variable causes large estimated variances of the coefficients, and as a result our probability inferences about the parameters are less precise. An conclusion here would be that it is better to include irrelevant variables than to omit relevant ones.

CHAPTER 6

6. RESULTS

6.1 Analysis of the Regression Results

The results of the estimations are presented in three different sections, one for each quota type. As earlier described, the provinces of Ontario and Quebec have a relatively long quota trade history, and supply a large body of data well suited for estimation purposes. Alberta, on the other hand, has a short quota trade history and few quota price observations with large variation. In the following sections, the analyses are therefore concentrated on the results from Ontario and Quebec by using 5 percent as the level of significance. Alberta results are listed in Appendix 5, Table 1,2, and 5.

In general, the proposed models provide much better and more consistent results when explaining industrial milk quota prices than fluid milk quota prices. The fluid quota results for Ontario and Quebec are therefore listed in Appendix 5, Table 3 and 4.

6.1.1 Unused MSQ

ONTARIO

The restricted model (Model 1a) performs reasonably well in the case of Unused MSQ in Ontario. The constant term, the net profit variable, the political risk variable, and the over-quota levy variable are all significant with the expected signs in front of the coefficients. In terms of coefficients, the net profit variable is the most important, while the industrial milk price variable is perceived as most important in terms of elasticities. However, although

Table 6.1: Unused MSQ Results: Ontario

MODEL TYPE	MODEL 1a RESTRICTED MODEL		MODEL 1b LOGARIT. RESTRICTED MODEL		MODEL 2a LOGARIT. ADAPTIVE MODEL		MODEL 2b LOGARIT. FACTORED MODEL	
	n= 133 R^2-ad.= 0.93 DW= -[1]		n= 133 R^2-ad. = 0.92 DW= -		n= 133 R^2-ad.= 0.95 DW= -0.09		n= 133 R^2-ad.= 0.93 DW= (h) -0.03	
ONTARIO	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**64.42** **(4.85)**	**2.98**	**6.79** **(4.80)**	-	**0.69** **(2.31)**	-	0.63 (1.29)	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.55** **(12.08)**	-	**0.37** **(5.74)**	-
NET PROFIT	**1.05** **(13.40)**	**0.34**	**0.24** **(11.11)**	-	**0.15** **(8.58)**	-	**0.51**[2] **(7.38)**	-
IND. MILK PRICE	**-4.39** **(-3.61)**	**-2.02**	**-1.81** **(-3.06)**	-	0.23 (1.80)	-	0.05 (0.24)	-
FLUID QUOTA PRICE	-0.27 (-1.82)	-0.21	-0.08 (-0.68)	-	0.04 (0.47)	-	0.01 (0.13)	-
POLITICAL RISK	**-0.13** **(-3.03)**	**-0.40**	**-0.08** **(-3.60)**	-	**-0.01** **(-2.11)**	-	**-0.04** **(-3.54)**	-
INTEREST RATE(%)	-0.11 (-0.65)	-0.06	-0.01 (-0.75)	-	**-0.02** **(-4.46)**	-	-0.03 (-0.38)	-
OVER-QUOTA LEVY	**1.07** **(2.38)**	**0.38**	0.41 (1.58)	-	0.04 (0.62)	-	0.05 (0.44)	-

significant, the latter variable carried an unexpected negative sign. The other proposed variables are insignificant at a 5 percent level. When estimating the same model with the data in logarithmic form (Model 1b), the over-quota levy variable is no longer significant, but, the t-statistics are similar to the t-statistics in Model 1a. In the logarithmic adaptive expectation

[1] Due to the estimation method in SHAZAM, no Durbin-Watson coefficient is calculated for the restricted model.

[2] There is no net profit variable in the factored model; instead another quota asset, the price of Used MSQ, is used to explain the price of Unused MSQ.

model (Model 2a), a few changes can be observed in the results. The constant term, the net profit variable, and the political risk variable are also significant, but in addition, the interest rate variable is negative and significant. The industrial milk price is now positive, although only weakly significant; and this can be considered an improvement compared to Model 1a and 1b, where the milk price variable has a negative sign. The political risk and the interest rate coefficients are both very small, meaning that the net profit variable and the lagged dependent variable are the major explanatory factors for price formation in this model. An interesting aspect of this model, is the estimated coefficient of expectation. A coefficient of 0.55 means that the average response on Unused MSQ prices to a unit change in the net profit variable is 55 percent. In Model 2b, the factored model, it can be observed that all variables have lower t-statistics, except for the political risk variable, which has an increased t value.

QUEBEC

The results for Unused MSQ in Quebec using the restricted model (Model 1a) is different compared to the results presented for Ontario. Here, the constant term, the net profit variable, the fluid quota price variable, and the interest rate variable are all significant with the expected signs. The second assessment tax variable[14] is also significant, but the estimated coefficient suggests a quota price increase of more than twice the amount of the tax increase, indicating that this variable might capture other effects than just the tax increase. The other proposed variables in the model are insignificant. When using the restricted model with logarithmic data (Model 1b), the fluid quota price variable and the second assessment tax

[14] See Chapter 5.2.4.

Table 6.2: Unused MSQ Results: Quebec

MODEL TYPE	MODEL 1a		MODEL 1b		MODEL 2a		MODEL 2b	
	RESTRICTED MODEL		LOGARIT. RESTRICTED MODEL		LOGARIT. ADAPTIVE MODEL		LOGARIT. FACTORED MODEL	
	n= 54 R^2-ad.= 0.95 DW= -		n= 54 R^2-ad. = 0.91 DW= -		n= 54 R^2-ad.= 0.96 DW= -0.96		n= 54 R^2-ad.= 0.95 DW= (h) 0.30	
QUEBEC	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**20.23** **(2.28)**	**0.82**	**3.03** **(2.59)**	-	1.20 (1.52)	-	1.64 (1.91)	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.53** **(6.71)**	-	**0.40** **(2.95)**	-
NET PROFIT	**1.35** **(13.30)**	**0.37**	**0.35** **(9.03)**	-	**0.22** **(6.93)**	-	**0.69**[1] **(4.76)**	-
IND. MILK PRICE	-0.29 (-0.43)	-0.11	-0.19 (-0.43)	-	0.09 (0.33)	-	-0.52 (-1.73)	-
FLUID QUOTA PRICE	**0.21** **(3.87)**	**0.19**	0.09 (1.93)	-	0.04 (1.41)	-	-0.00 (-0.05)	-
INTEREST RATE(%)	**-0.60** **(-3.83)**	**-0.25**	**-0.04** **(3.73)**	-	**-0.02** **(-3.66)**	-	-0.01 (-1.15)	-
OVER-QUOTA LEVY	-0.22 (-0.81)	-0.07	-0.00 (-0.01)	-	-0.10 (-1.14)	-	-0.13 (-1.36)	-
ASSESSMENT TAX 1	0.74 (0.55)	0.01	0.03 (0.39)	-	0.00 (0.02)	-	**-0.18** **(-3.18)**	-
ASSESSMENT TAX 2	**2.91** **(3.40)**	**0.03**	0.08 (1.49)	-	0.02 (0.69)	-	**-0.13** **(-3.69)**	-
CUSTA	2.39 (1.63)	0.00	0.07 (0.80)	-	0.06 (1.14)	-	0.11 (1.79)	-
GATT	0.65 (0.74)	0.00	0.06 (0.95)	-	0.04 (1.20)	-	0.07 (1.72)	-

[1] There is no net profit variable in the factored model; instead another quota asset, the price of Used MSQ, is used to explain the price of Unused MSQ.

change variable turn insignificant. The logarithmic adaptive expectation model (Model 2a), performs similarly to that estimated for Ontario. In addition to the adaptive expectation mechanism, only one variable, the interest rate, is significant. The adaptive expectation coefficient is 0.53, which is close to the 0.55 in Ontario, and means that Ontario and Quebec dairy producers adapt their expectations regarding Unused MSQ in a similar way. The results from the factored model (Model 2b) are hard to interpret in the case of the assessment tax variables. The estimated results surprisingly suggest that an increase in assessment tax lowers quota prices. It is difficult to explain how this possibly can be the case.

ALBERTA

The models for Unused MSQ in Alberta follow somewhat the results from the two other provinces, but differences can also be observed. In the restricted model (Model 1a), only the net profit variable and the constant term are significant, while the rest of the proposed variables are insignificant. This changes when we consider the logarithmic version of the restricted model (Model 1b), where the interest rate variable also turns significant. In the logarithmic version of the adaptive expectation model (Model 2a), the net profit and the fluid quota price variables are significant, in addition to the adaptive expectation variable. The estimated coefficient of adaptive expectations is very low, 0.33, which means that Alberta dairy farmers have close to naive net profit expectations (λ=0). The over-quota levy variable is here significant, but unexpectedly negative. The other proposed variables are insignificant, including the constant term. The factored model (Model 2b) provides reasonable results, except for the industrial milk price variable, which is negative and highly significant. The fluid quota price variable and the over-quota levy variable are here no longer significant.

6.1.2 Used MSQ

ONTARIO

Table 6.3: Used MSQ Results: Ontario

MODEL TYPE	MODEL 1a RESTRICTED MODEL		MODEL 1b LOGARIT. RESTRICTED MODEL		MODEL 2a LOGARIT. ADAPTIVE MODEL		MODEL 2b LOGARIT. FACTORED MODEL	
	n= 121 R^2-ad.= 0.79 DW= -		n= 121 R^2-ad. = 0.80 DW= -		n= 121 R^2-ad.= 0.89 DW= -0.52		n= 121 R^2-ad.= 0.94 DW= (h) -0.19	
ONTARIO	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**46.14** **(3.96)**	**3.15**	**7.51** **(4.13)**	-	**5.40** **(3.71)**	-	**1.81** **(3.21)**	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.90** **(16.09)**	-	**0.46** **(6.67)**	-
NET PROFIT	0.12 (1.31)	0.06	**0.10** **(2.56)**	-	**0.08** **(3.98)**	-	**0.63**[1] **(12.93)**	-
IND. MILK PRICE	**-3.43** **(-3.17)**	**-2.33**	**-2.55** **(-3.17)**	-	-0.07 (-0.53)	-	**-0.53** **(-2.25)**	-
FLUID QUOTA PRICE	-0.33 (-1.84)	-0.37	**-0.03** **(-2.10)**	-	**-0.26** **(-2.67)**	-	**-0.60** **(-5.58)**	-
POLITICAL RISK	-0.09 (-1.84)	-0.31	-0.00 (-1.91)	-	-0.00 (-0.07)	-	0.00 (1.02)	-
INTEREST RATE(%)	-0.09 (-0.49)	-0.07	-0.01 (-0.50)	-	**-0.01** **(-3.22)**	-	-0.01 (-1.75)	-
OVER-QUOTA LEVY	**1.70** **(3.59)**	**0.88**	**0.81** **(3.20)**	-	0.1 (1.49)	-	**0.31** **(2.80)**	-

When turning attention to the restricted model (Model 1a) for Used MSQ in Ontario, the model does not perform well. In addition to the constant term, only the industrial milk

[1] There is no net profit variable in the factored model; instead another quota asset, the price of Unused MSQ, is used to explain the price of Used MSQ.

price variable and the over-quota levy variable are significant, but the industrial milk price variable has an unexpected negative sign. Using logarithmic data in Model 1b improves the results in that the net profit variable becomes significant. The fluid quota price variable is now significant, but still negative. Otherwise, the results are similar to those from Model 1a. The results from the adaptive expectation model (Model 2a) are more encouraging compared to the results from Model 1a and 1b. In addition to the constant term, the lagged dependent variable and the net profit variable, the interest rate variable is significant. The fluid quota price variable is significant, but negative, and therefore unexpected. An increase in the adaptive expectation coefficient compared to the Unused MSQ results are also observed. A coefficient of 0.90 means that Used MSQ prices in Ontario will adapt 90 percent of a unit change in the net profit variable. Three differences can be observed in the factored model (Model 2b) as compared to the number of significant variables from Model 2a. First, the industrial milk price variable is significant, but again with a wrong sign. Second, the over-quota levy variable is significant, and third, the interest rate variable is insignificant.

QUEBEC

The Used MSQ results from Quebec using the restricted model (Model 1a), follow the trend of significant variables as in the Unused MSQ results from Ontario and Quebec. The net profit variable, the fluid quota price variable, and the interest rate variable are all significant in addition to the constant term. The second assessment tax increase variable and the CUSTA variable are also significant and positive. The other proposed variables are insignificant. These results do not change much when estimating the restricted model with logarithmic data (Model

Table 6.4: Used MSQ Results: Quebec

MODEL TYPE	MODEL 1a		MODEL 1b		MODEL 2a		MODEL 2b	
	RESTRICTED MODEL		LOGARIT. RESTRICTED MODEL		LOGARIT. ADAPTIVE MODEL		LOGARIT. FACTORED MODEL	
	n= 53 R^2-ad.= 0.93 DW= -		n= 53 R^2-ad. = 0.92 DW= -		n= 53 R^2-ad.= 0.94 DW= 0.30		n= 53 R^2-ad.= 0.97 DW= (h) -0.33	
QUEBEC	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**21.00** **(2.42)**	**1.18**	**2.53** **(1.98)**	-	**2.11** **(2.24)**	-	-0.30 (-0.52)	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.32** **(4.49)**	-	**0.15** **(2.81)**	-
NET PROFIT	**0.33** **(3.45)**	**0.13**	**0.13** **(3.04)**	-	**0.09** **(2.77)**	-	**0.58**[1] **(9.89)**	-
IND. MILK PRICE	-0.57 (-0.88)	-0.32	-0.44 (-0.95)	-	-0.27 (-0.77)	-	0.30 (1.53)	-
FLUID QUOTA PRICE	**0.41** **(4.34)**	**0.52**	**0.70** **(4.71)**	-	**0.28** **(2.12)**	-	0.13 (1.43)	-
INTEREST RATE(%)	**-0.54** **(-3.51)**	**-0.32**	**-0.04** **(-3.57)**	-	**-0.03** **(-4.23)**	-	**-0.01** **(-2.20)**	-
OVER-QUOTA LEVY	-0.54 (-1.80)	-0.22	-0.33 (-1.95)	-	-0.11 (-0.86)	-	-0.06 (-0.76)	-
ASSESSMENT TAX 1	-0.29 (-0.21)	-0.01	-0.06 (-0.61)	-	-0.03 (-0.48)	-	0.06 (1.45)	-
ASSESSMENT TAX 2	**1.98** **(2.18)**	**0.03**	0.02 (0.30)	-	0.03 (0.70)	-	**0.07** **(2.77)**	-
CUSTA	**2.88** **(2.00)**	**0.01**	0.17 (1.65)	-	0.13 (1.83)	-	0.03 (0.60)	-
GATT	0.65 (0.76)	0.00	0.06 (0.98)	-	0.06 (1.35)	-	0.02 (0.71)	-

1b), except that the assessment tax variable and the CUSTA variable have turned insignificant. The net profit, the fluid quota price, and the interest rate variables in the logarithmic adaptive

[1] There is no net profit variable in the factored model; instead another quota asset, the price of Unused MSQ, is used to explain the price of Used MSQ.

expectation model (Model 2a), are significant in addition to the constant term and the lagged dependent variable. The estimated adaptive coefficient is 0.32, which means that Used MSQ prices in Quebec will adapt 32 percent of a unit change in the net profit variable. In Model 2b, the factored model, the lagged dependent variable, the net profit variable, the interest rate variable, and the second assessment tax variable are significant. The other variables are insignificant.

ALBERTA

Except for the constant term, the restricted model (Model 1a) for Used MSQ in Alberta provides no significant variables. The estimation of the restricted model with logarithmic data in Model 1b, gives a significant value for the interest rate variable. The adaptive expectation model (Model 2a) presents significant t-statistics on the lagged dependent variable, the net profit variable, and the fluid quota price variable. Here, the adaptive expectation coefficient has the value of 0.77, which means that Used MSQ prices in Alberta will adapt 77 percent of a unit change in the net profit variable. The rest of the proposed variables are insignificant. In the factored model (Model 2b), the same variables are significant as in the adaptive expectation model.

6.1.3 Fluid Quota

When a summary of the results for the fluid quota models now are presented, it is useful to keep in mind that while the markets for Unused and Used MSQ are closely related, the characteristics of the fluid quota market are somewhat different, both regarding the quota

regulations and dairy producers incentives to enter the quota exchange market. The estimated results are listed in Appendix 5.

ONTARIO

In the restricted model for fluid quota prices in Ontario, the Used MSQ price variable and the interest rate variable are significant, in addition to the constant term. The net profit variable, the fluid milk price variable and the policy risk variable are not significant, although, the policy risk variable is significant at the 10 percent level. Applying logarithmic data on the restricted model (Model 1b), the political risk variable becomes significant, and slightly improves the results. The t-statistics on the other significant variables are similar to the results in Model 1a. The adaptive expectation mechanism does not perform particularly well in the fluid quota price model (Model 2a). The adaptive expectation variable is one out of two significant variables, with a value of 0.95. This means that fluid quota prices in Ontario will adapt 95 percent of a unit change in the net profit variable. The other significant variable is the interest rate.

QUEBEC

The results for fluid quota prices in Quebec are not very informative with regard to the proposed price function. Only the interest rate variable is consistently significant in Model 1a, 1b, and 2a. The logarithmic adaptive expectation model (Model 2a) can provide three significant variables; the lagged variable, the net return variable, and the interest rate variable. The adaptive expectation coefficient is 0.86, which means that fluid quota prices in Quebec will adjust 90 percent of a unit change in the net profit variable.

ALBERTA

As for the Quebec results, the proposed price function does not perform very well for fluid quota prices in Alberta. The two restricted models, Model 1a and 1b, hardly provide any significant information. In Model 2a, the adaptive expectation model, the adaptive expectation coefficient has a value of 0.1. This is in the other end of the range between 0 and 1, compared to the value of 0.95 in Ontario and 0.86 in Quebec. Here, the fluid milk price and the interest rate variables are also significant.

6.1.4 Comparisons of the Estimations

The proposed proxy for net profit, as described in Chapter 4, Equations 4.1 to 4.4, is close to significant at the 5 percent level for all three provinces for Unused and Used MSQ. The exceptions are in the results for Used MSQ in Ontario and Alberta in the restricted model. In the fluid quota price results, the net profit variable is only significant in the adaptive expectation model in Alberta. The size of the coefficients differ with quota type, and is highest in the Unused MSQ results, followed by the Used MSQ results.

The milk price variable was expected to be positive and significant. This is true only in the results from the adaptive expectation model for fluid quota milk in Alberta. In all other models, the milk price variable is either insignificant, or significant and negative.

The alternative quota variable is not significant for Unused MSQ in Ontario, and only significant for the restricted model for Unused MSQ in Quebec. In Alberta, the alternative quota variable is significant in the adaptive expectation model. When we consider the influence of this variable on Used MSQ prices, the variable is significant and negative in the Used MSQ

results from Ontario, and positive in the Used MSQ results from Quebec. Significant and positive results can also be observed in the adaptive expectation model for Used MSQ in Alberta. Using the price of Used MSQ as an alternative quota investment is positive and significant in the restricted model for fluid quota prices in Ontario. The same variable is also significant, but negative in the restricted model for fluid quota prices in Alberta. The variable is insignificant in the other models.

The bidder success rate in Ontario, used to represent political risk, is significant and negative in the restricted model for fluid quota prices, and in all the models for Unused MSQ. In the other Ontario models, the variable is still negative, but insignificant. The time dummy variables for two separate periods, one trying to capture the effects of the NAFTA negotiations, and the other capturing the effects from the GATT negotiations, are both insignificant when Used in the Quebec quota price models, except for the restricted model for Used MSQ, where the CUSTA variable is significant but with an unexpected positive sign.

The interest rate variable is significant and negative in the majority of the results. The variable is always significant in the results from the Quebec quota price models, but not always significant in the results from the Ontario and Alberta quota price models. The interest rate variable seems to be more consistently significant in the fluid quota price models.

The two assessment tax variables in the Quebec models are in general not significant. The exceptions are in the results from the restricted models for Unused and Used MSQ, where the variable for the second assessment tax change is significant. The variable for over-quota levy is only significant and positive in a few of the models for MSQ prices in Ontario.

The adaptive expectation coefficients from Model 2a are summarized in Figure 6.1. These estimations indicate how current period unit changes in the net profit variable is passed

on to milk quota prices. In general, the coefficients tell us that unit changes in the net profit variable is more completely passed on to Used MSQ prices and fluid milk quota prices, than to Unused MSQ prices, since Unused MSQ has the lowest coefficients, followed by Used MSQ and fluid milk quota coefficients, although the Used MSQ coefficient for Quebec and the fluid quota coefficient for Alberta deviate from this pattern with rather low values. Fluid quota trade in Alberta has a short history, so these results may arise from the small amount of data. The low Quebec coefficient is more surprising.

Table 6.1: Comparing the Coefficients of Adaptive Expectations

	Estimated Coefficient
Unused MSQ	
Ontario	0.55
Quebec	0.53
Alberta	0.33
Used MSQ	
Ontario	0.90
Quebec	0.32
Alberta	0.77
Fluid Milk Quota	
Ontario	0.95
Quebec	0.86
Alberta	0.10

6.2 Evaluation of the Results

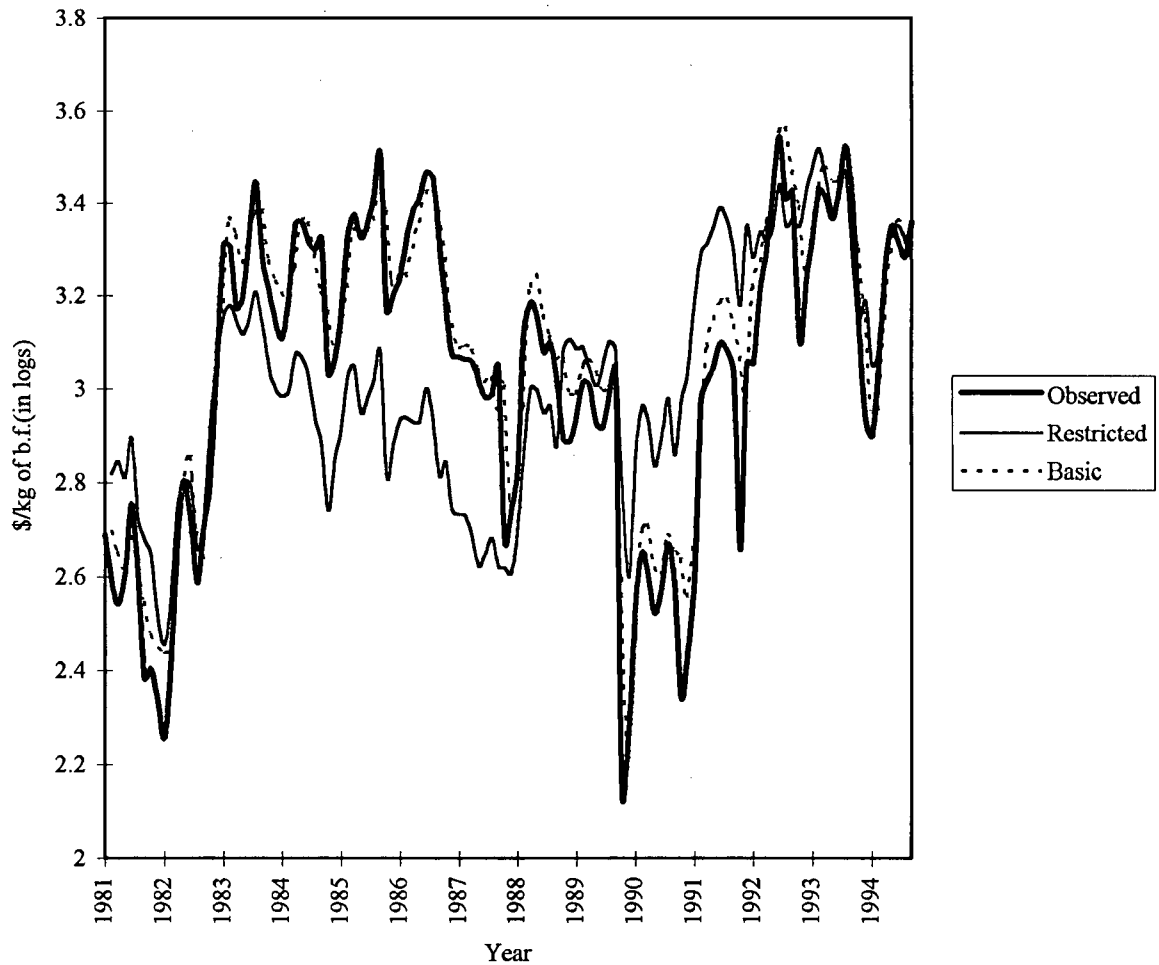
6.2.1 Results

A large variation in results between provinces, quota types, and models, is observed, and it is difficult to reveal very consistent patterns in the results. In general, the results, when trying to explain MSQ prices, are better than when trying to explain fluid quota prices. The coefficients in the restricted models obtain higher values than in the adaptive expectation models. This is no surprise since the extra variable, the lagged dependent variable, is included in the adaptive expectation model, and therefore reduces the size of the coefficients on the other variables. For the estimated models, the calculated values of adjusted R^2 are in the range between 0.48 and 0.96. Lower values are observed in restricted models, especially in Alberta, while the adaptive expectation models obtain the highest values. This is also not surprising, since the adaptive expectation model is strongly influenced by the lagged dependent variable.

As illustrated in Figure 6.1, the adaptive expectation model for Unused MSQ in Ontario is capable of more closely following the observed quota prices when quota prices are predicted. When a lagged version of the dependent variable is included in the estimated equation, as it is in the adaptive expectation model, this variable has a decisive impact on the results. Predicted values will therefore never be far away from the observed values. However, the disadvantage with this model is, that when the cycles turn from a positive to a negative price trend, the adaptive expectation model will not be capable of capturing this changes until after the change actually took place, unless some sort of a signal is provided in the data. Figure 6.1 illustrates this effect, where the predicted results from the adaptive expectation model seem to continue an increasing or declining trend, one period more than it should. Only

the Unused MSQ results are graphed in Figure 6.1, but similar observations can be made for the other quota types. When the restricted model is used for predictions, larger deviations compared to the observed quota prices are seen. On the other hand, the lagged dependent variable is not among the explanatory variables in this model, such that the influence from the other variables in the proposed price functions will be better exposed.

Figure 6.1: Comparison of Predicted and Observed Quota Prices: Unused MSQ in Ontario.

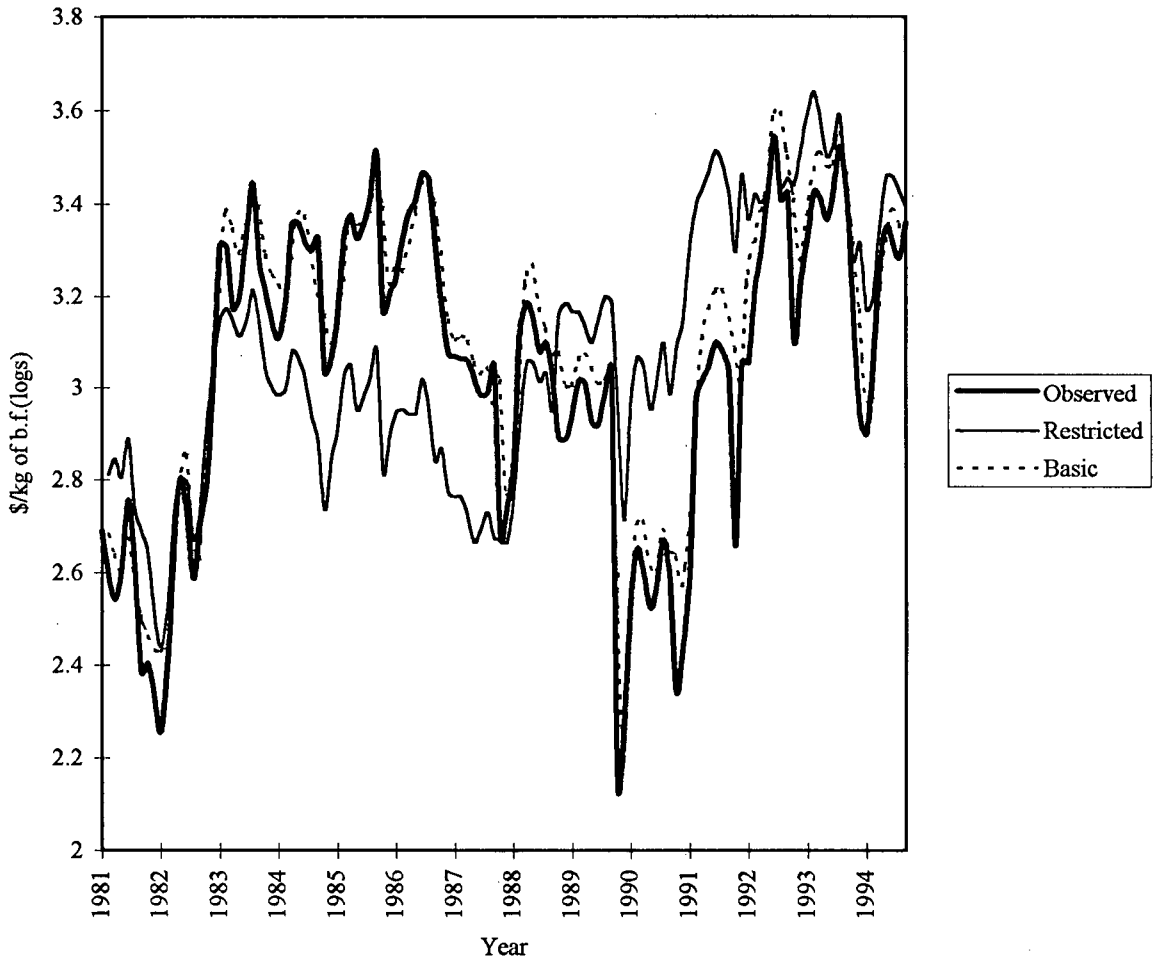


When considering the results from all quota types and provinces, a general trend shows that the net profit variable and the interest rate variable have the main influence in the formation of milk quota prices. It was unexpected that the political risk variable would be significant only for Unused MSQ in Ontario. The variable that involves the possibilities for an alternative quota investment seems to be a significant variable for Used MSQ, since the level of the fluid quota price influences the price determination of Used MSQ. It is difficult to predict how integrated the price formation of the different quota types is, but it is not unreasonable to believe that prices of Used MSQ follow the price trends in the two other quota types. Use of the milk price as a long-run measurement for net profit was more or less consistently rejected in the estimations. This was not surprising, since the observed real milk prices gradually have declined, while the observed real quota prices in general have increased with time.

6.2.2 Robustness of the Proposed Models

One method to test out the robustness of the proposed models, is to estimate the coefficients based on an earlier part of the available data set, and then use these coefficients to predict future quota prices. The predicted quota prices after July 1991 in Figure 6.2, are based on coefficients estimated from the data from 1981 to July 1991. Compared to the results in Figure 6.1, where all the data were used for estimation, the adaptive expectation model in Figure 6.2 is not that capable of predicting values close to the observed quota price. Larger deviations in the predictions is observed when using the restricted model.

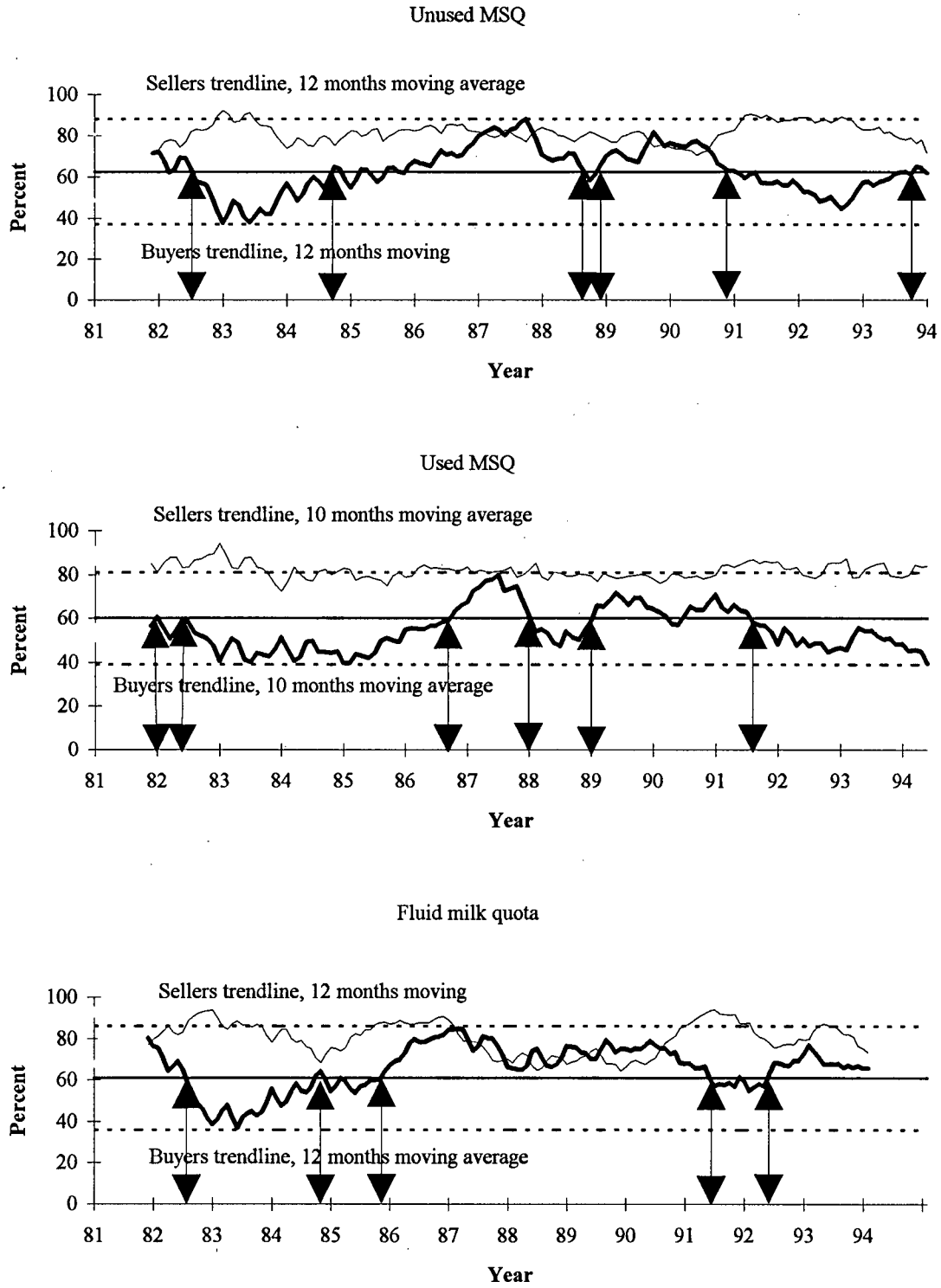
Figure 6.2: Robustness of the Model: Forecast of Unused MSQ Prices in Ontario after July 1991.



6.3 Quota Price Predictions

Many dairy producers will not only be concerned about how quota prices are formed, but also the timing of an increase in low quota price cycles, or the timing of a decrease in high quota price cycles. By looking at the observed quota price data, it is hard to tell if a price trend is turning, or if a value can be explained with seasonal or random variation. A tool for predicting quota price turning points could be very handy for all actors in the quota market.

Figure 6.3: Trends in Quota Prices: Ontario



Source: DFO

If we take a closer look at the bid/offer success rates from Ontario, the data series provide the possibility for an interesting approach to this important question. If we assume that the medium bidders success rate lines in Figure 6.3, also represents a medium or "neutral" risk, then bidders success rate values above the mean line should indicate expectations of increased political risk and therefore lower quota prices, and values under the mean line should indicate the opposite. If we look at the buyers trendlines[15] in Figure 6.3, mark the months where the buyers trendline cross the mean line, and then compare these "line-crossings" with the quota prices in Figure 1.1, it can be observed that the closer the bidders success line gets to the mean line, the higher the chance for change in the cycle of quota prices. In the time period between 1981 and 1994, the buyers success rate crossed the mean line 17 times for all three quota types. For most of these 17 line- crossings, a turning point in quota prices can also be observed. It is, however, a problem that the "line-crossings" are supposed to reflect changes in policy risk, but they should then be the same for Unused and Used MSQ. This is not always the case, and indicates that this simple data analysis not is sufficient to fully understand how quota price cycles can be predicted.

6.4 Final Remarks - Results and Analysis

Throughout this research process I ran into several problems. The choice of model was a major and difficult decision, and the results from the adaptive expectation model are not very consistent across provinces and quota types, and this calls for some reflection. The proposed quota price functions (4.5-4.7) are estimated through an adaptive expectation model using real world data, and large variation in the results can be seen. But in spite of this variation in

[15] See Chapter 3.5.4.

results, I have no reason to believe that the proposed price functions are wrong. The variation in results might just as well be caused by an incomplete model, by incomplete data, by using proxy's for net profit and policy risk that are not accurate enough, or by weakness in the estimation procedure.

It would have been interesting to see the results in a dynamic approach, where a more thorough treatment of the risk aspects would be applied to the same data set. More data from the quota exchanges, especially the distribution of reservation prices, could develop a more accurate theory of risk behavior and help us to better understand the functioning of the quota markets. It is also possible that the use of an instrumental variable during the estimation of the empirical model, could obtain more reliable results and help us to solve some of the econometrical issues.

Nevertheless, even if there are several sources for mistakes, this work is carried out with best intentions, and no attempt has been done to hide any practical or theoretical problems.

CHAPTER 7

7. CONCLUSIONS

1. The milk quota auction is not a perfectly understood marketplace. The history of milk quota prices supports this statement with the data of Figure 5.1, where the difference between Unused and Used MSQ during some time periods, far exceeds the level of the over-quota penalty. Given the quota buyers choice to either buy Used MSQ and pay the over-quota levy, or buy Unused MSQ, it is difficult to explain this phenomena in a rational way. This remains as a puzzle to be explained in future work.

2. The analysis and the results support the argument that volatility in Unused MSQ prices is generated by short-run factors. Also, even if the Used MSQ market mainly has long-run characteristics, arbitrage possibilities between Unused and Used MSQ imply strong correlation between the quota prices. The fluid quota market appears to be driven mainly by long-run considerations.

3. The proposed price functions, including net profit, interest rate, political risk, milk prices, over-quota levy, and assessment taxes, seem to explain better industrial milk quota prices than fluid milk quota prices, when estimated in an adaptive expectation framework.

4. The estimated adaptive expectation coefficients indicate how unit changes in the net return variable are passed on to milk quota prices. In general, the coefficients tell us that unit changes in the net profit variable are more completely passed on to Used MSQ prices and

fluid milk quota prices, than Unused MSQ prices, since Unused MSQ has the lowest coefficients, followed by Used MSQ and fluid milk quota coefficients.

5. An appealing theory supports the suggested short-run net profit variable. But, some uncertainty is connected with the use of this measurement. It is therefore interesting to see that this variable turned out to be statistically significant when applied to the chosen models for industrial milk quota prices.

6. Casual observations during trade negotiations of the late 1980's and the early 1990's would suggest that fears of increased risk of an abandonment of the supply management regime lowered the quota prices during that period. The bidders success rate from the quota exchange in Ontario is used as a basis for the analysis of policy risk, and the data strongly support the statement of increased political risk during trade negotiations. Introducing the bidders success as a variable in the quota price model was not a complete success, indicating that the risk relations might be more complex. This might explain why previous work often has failed when simple measurements to explain risk (e.g., time dummy variables) have been used.

7. The fluid quota prices are more stable than industrial milk quota prices. If explaining this from a risk point of view, it indicates that dairy producers perceive fluid quota to be a more secure investment, even if the rent associated with fluid milk is higher than for industrial milk. This suggests that trade liberalization of industrial products was more expected among the producers than an opening up of borders for fluid milk trade.

8. This analysis has been able to answer important questions regarding the formation of Canadian milk quota prices. However, some areas could be explored further to obtain a better understanding of the functioning of milk quota markets. To accurately calculate net profit from holding quota could help us explain the variation in milk quota prices. The functioning of the quota exchange could also be better understood if we had more data from the quota exchange. At last, solving econometric issues could help us to trust the estimated results.

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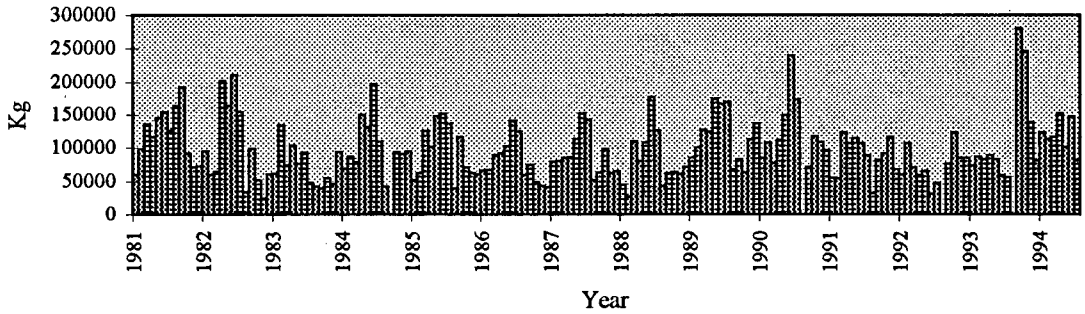
Appendix 1: Quantities of Exchanged Quota

Figure A1.1: Ontario Quota Quantities

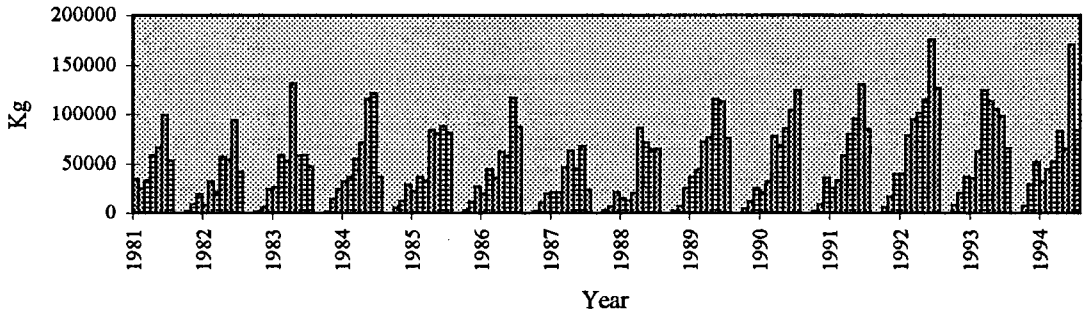
I

Quantity Unused MSQ traded, ONTARIO, Jan.1981-July 1994



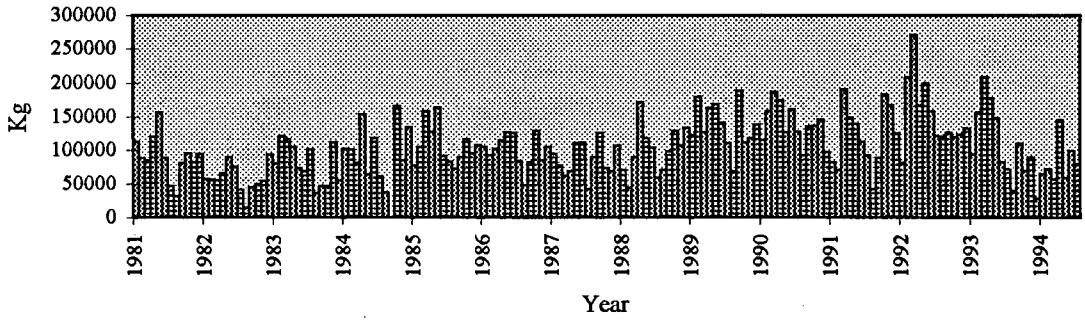
II

Quantity Used MSQ traded, ONTARIO, Jan.1981-July 1994



III

Quantity Fluid Quota traded, ONTARIO, Jan.1981-July 1994

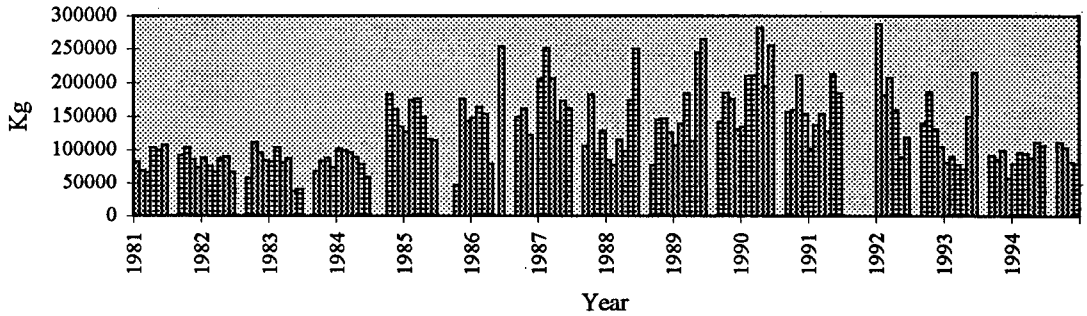


Source: Dairy Farmers of Ontario.

Figure A1.2: Quebec Quota Quantities

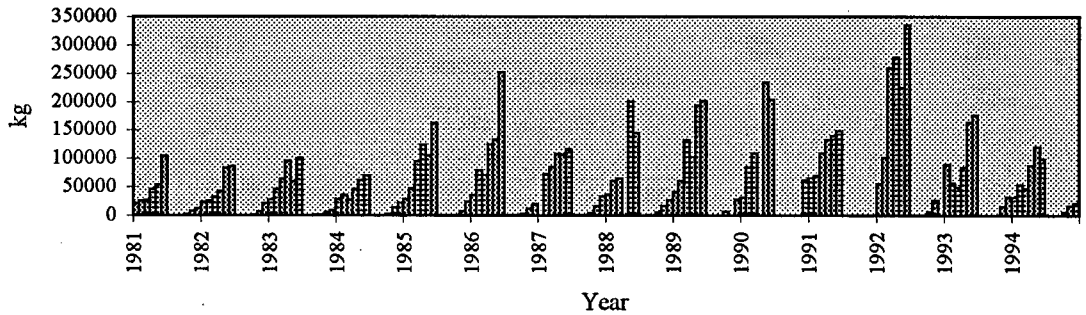
I

Quantity Unused MSQ traded, QUEBEC, Jan.1981-Dec.1994



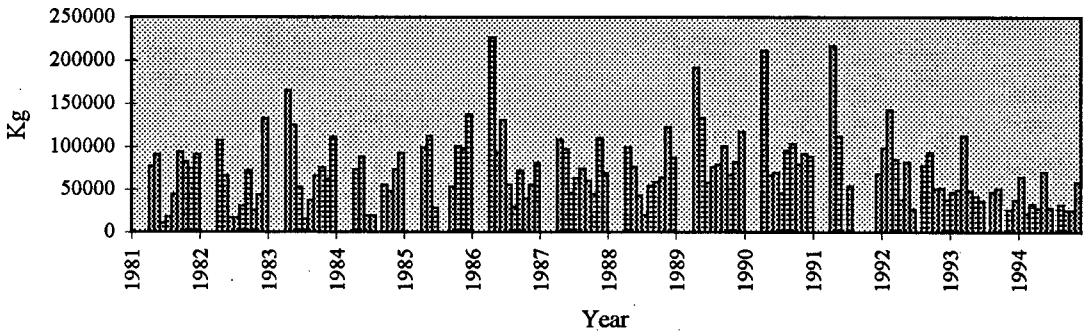
II

Quantity Used MSQ traded, QUEBEC, Jan.1981-Dec.1994



III

Quantity Fluid Quota traded, QUEBEC, Jan.1981-Dec.1994

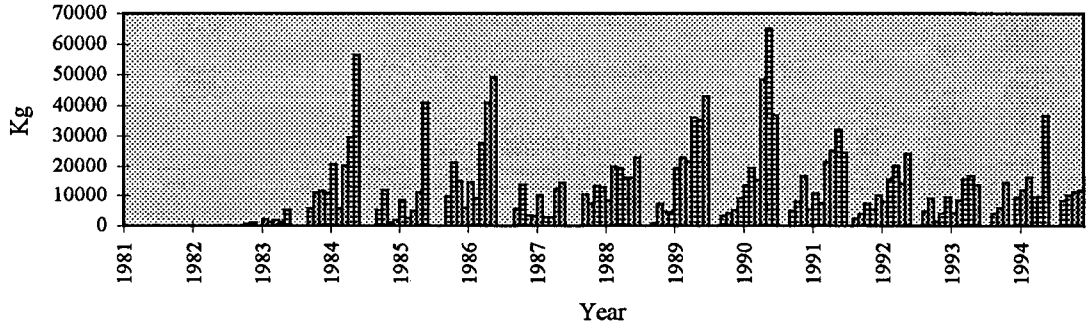


Source: Le Federation des Producteurs de Lait, Quebec.

Figure A1.3: Alberta Quota Quantities

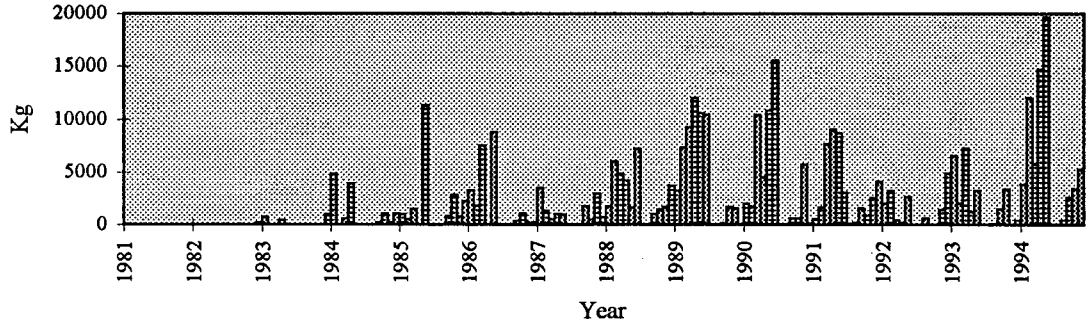
I

Quantity Unused MSQ traded, ALBERTA, Jan.1981-Dec.1994



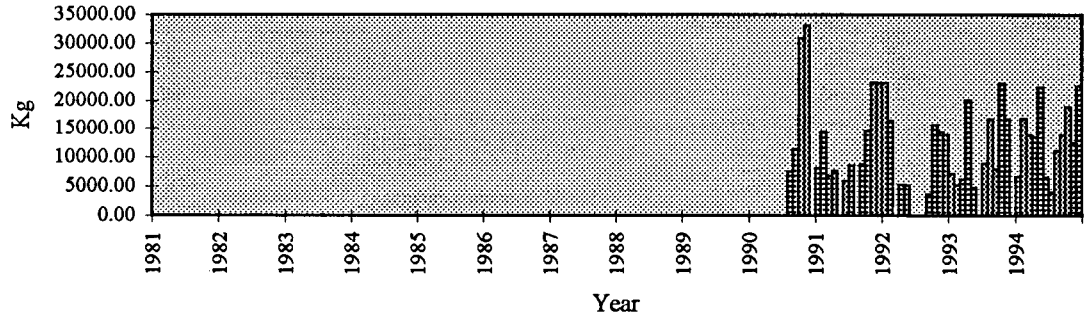
II

Quantity Used MSQ traded, ALBERTA, Jan.1981-Dec.1994



III

Quantity Fluid Quota traded, ALBERTA, Jan.1981-Dec.1994



Source: Alberta Dairy Control Board.

Appendix 2: A Summary of Major Political Events of Importance for the Supply Management System.

CUSTA

Sept. 26, 1985;	Canada and US plan to seek a trade agreement.
Feb. 21, 1986;	A mainframe of negotiations subjects takes form.
May 21, 1986;	"Free trade" negotiations are expected to begin.
Sept. 1986;	First time the supply management system was discussed.
Nov. 13, 1986;	Trade barriers are going up, not down.
Jan. 28, 1987;	"The US is seeking fundamental changes to Canadian Agricultural policies in the bilateral trade talks" (Globe and Mail), including removal of all trade barriers.
Feb. 26, 1987;	Negotiations have gone from a exploratory phase to a drafting phase.
Oct. 3, 1987;	Canada - US Free Trade Agreement reached. The agricultural package is relatively small.
Jan. 2, 1988;	Agreement signed.
Jan. 18, 1988;	The Government of Canada protects the Canadian dairy industry from the threat of imports of certain US dairy products. Ice-cream, yogurt and other dairy products were added to the Import Control List.
	Ratification

Jan. 1, 1989;	Agreement scheduled to go into place.

GATT

Sept. 15, 1986;	A new round of multilateral trade negotiations launched.
Jan. 29, 1987;	A new timetable reached. Next meeting in Geneva.
May 14, 1987;	OECD Ministers pledge to cut farm subsidies.
Feb. 25, 1988;	Progress: So far so good.
June 1989;	Dairy Farmers concerned about the milk price cap. Dairy farmers have been extremely critical of the federal governments action to cap the industrial price of milk.
June 29, 1989;	Countries remain split over the Chairman's Text. Dairy producers not satisfied.
	Various proposals.
Dec. 20, 1991;	Canada concerned over the Dunkel proposal regarding the possibilities to preserve the domestic supply management system.
Dec. 15, 1993;	GATT agreement reached.
Dec. 1994;	GATT agreement signed.

Appendix 3: The Lag Operator

Consider again the general distributed lag model:

$$y_t = \sum_{i=0}^{\infty} w_i x_{t-i} + u_t \tag{A3.1}$$

By writing $x_{t-i} \equiv L^i x_t$, where L is the lag operator described by Dhrymes (1971), and substititing this into (A3.1), we find

$$y_t = W(L)x_t + u_t, \qquad W(L) = \sum_{i=0}^{\infty} w_i L^i \tag{A3.2}$$

To determine whether the operator *W(L)* is meaningful, we need to examine the conditions under which the corresponding power series, $W(t) = \sum_{i=0}^{\infty} w_i t^i$ converge. This will entail some constraints on the lag coefficients, $w_i : i = 0,1,2,\ldots$ The radius of convergence of this power series must at least contain $t = 1$.

Consider the special case where the coefficients w_i, above, are given by

$$w_i = \alpha\lambda^i \tag{A3.3}$$

The operator *W(L)* of (A3.2) now becomes

$$W(L) = \alpha \sum_{i=0}^{\infty} \lambda^i L^i \tag{A3.4}$$

What meaning is it to be ascribed to this? Well, if we proceeds as follows: For t∈R, we have that

$$W(t) = \alpha \sum_{i=0}^{\infty} (\lambda t)^i = \frac{\alpha}{1-\lambda t} \tag{A3.5}$$

is valid, provided $$|\lambda t| < 1 \tag{A3.6}$$

Since we wish this representation to be valid for t = 1, we conclude from (A.6) that the restriction on λ is

$$\lambda \in (-1,1) \tag{A3.7}$$

For such λ, replacing in (A3.5) t and its powers by L and its powers, we find

$$W(L) = \frac{\alpha I}{I - \lambda L} \tag{A3.8}$$

where I is the identity matrix. This is an interesting development, in that it leads naturally to the notion of the inverse of an lag operator, T. Such inverses need not always exist. It is clear that if we put

$$T = \frac{I}{I - \lambda L} \tag{A3.9}$$

then $$(I - \lambda L)T = I \tag{A3.10}$$

To verify the validity of (A3.10), let x be any element of X. Then it must be true that

$$(I - \lambda L)\left[\frac{I}{I - \lambda L}x(t)\right] = x(t) \tag{A3.11}$$

In terms of the equivalence derived earlier, we know that

$$(I - \lambda L) * \frac{I}{I - \lambda L}$$

corresponds to $(1-\lambda t)(1/1-\lambda t)$. But for λ as in (A3.7) and $|t| < 1$, this last quantity clearly yields unity which, therefore, proves (A3.10).

A further convenience of the operator representation is seen as follows: If $W(L)$ is as in (A3.8), then the model in (A3.2) may be written as

$$y_t = \frac{\alpha I}{I - \lambda L} x_t + u_t \tag{A3.12}$$

Applying now I - λL to both sides we obtain, in view of (A3.11),

$$y_t = \lambda y_{t-1} + \alpha x_t + u_t - \lambda u_{t-1} \tag{A3.13}$$

which is a simpler form and rather easier to work with.

Appendix 4: Correlation Matrixes

Appendix 4.1 Correlation Matrix: Ontario

	PUNUSED	PUSED	PFLUID	NRIND	NRFLUID	MPIND	MPFLUID	r	PRUNUSED	PRUSED	PRFLUID	OQL
PUNUSED	1											
PUSED	0.89	1										
PFLUID	0.77	0.78	1									
NRIND	0.8	0.44	0.53	1								
NRFLUID	0.8	0.44	0.49	0.99	1							
MPIND	0.02	-0.02	-0.24	0.06	0.14	1						
MPFLUID	0.03	0	-0.3	0.05	1.14	0.97	1					
r	-0.65	-0.7	-0.81	-0.37	-0.31	0.48	0.5	1				
PRUNUSED	-0.45	-0.31	-0.14	-0.47	-0.51	-0.08	-0.17	0.18	1			
PRUSED	-0.35	-0.33	0	-0.26	-0.32	-0.32	-0.42	-0	0.78	1		
PRFLUID	-0.5	-0.33	-0.22	-0.54	-0.56	-0.26	-0.26	0.14	0.78	0.68	1	
OQL	0.56	0.53	0.64	0.4	0.4	0.39	0.31	-0.3	-0.06	-0.03	-0.26	1

Appendix 4.2 Correlation Matrix: Quebec

	PUNUSED	PUSED	PFLUID	NRIND	NRFLUID	MPIND	MPFLUID	r	OQL
PUNUSED	1								
PUSED	0.9	1							
PFLUID	0.82	0.87	1						
NRIND	0.61	0.2	0.27	1					
NRFLUID	0.47	0.03	0.11	0.97	1				
MPIND	-0.56	-0.68	-0.49	-0.03	0.14	1			
MPFLUID	-0.62	-0.75	-0.61	-0.04	0.17	0.95	1		
r	-0.83	-0.89	-0.87	-0.25	-0.08	0.62	0.73	1	
OQL	0.3	0.14	0.4	0.41	0.38	0.3	0.16	-0.34	1

Appendix 4.3 Correlation Matrix: Alberta

	PUNUSED	PUSED	PFLUID	NRIND	NRFLUID	MPIND	MPFLUID	r	OQL
PUNUSED	1								
PUSED	0.83	1							
PFLUID	0.5	0.64	1						
NRIND	0.83	0.38	0.14	1					
NRFLUID	0.82	0.38	0.16	1	1				
MPIND	-0.3	-0.16	0.25	-0.33	-0.29	1			
MPFLUID	-0.31	-0.17	0.26	-0.35	-0.3	0.98	1		
r	-0.66	-0.73	-0.72	-0.36	-0.34	0.15	0.18	1	
OQL	0.31	0.38	0.69	0.13	0.16	0.47	0.47	-0.49	1

Appendix 5: Results

Table A5.1: Unused MSQ Results: Alberta

MODEL TYPE	MODEL 1a RESTRICTED MODEL		MODEL 1b LOGARIT. RESTICTED MODEL		MODEL 2a LOGARIT. ADAPTIVE MODEL		MODEL 2b LOGARIT. FACTORIZED MODEL	
	n= 23 R^2-ad.= 0.85 DW= -		n= 23 R^2-ad.= 0.82 DW= -		n= 23 R^2-ad.= 0.92 DW= (h) -1.17		n= 23 R^2-ad.= 0.80 DW= (h) -0.47	
ALBERTA	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**17.54** **(2.61)**	**0.69**	**2.70** **(4.85)**	-	-0.50 (-0.92)	-	**1.39** **(2.05)**	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.33** **(5.72)**	-	**0.22** **(1.97)**	-
NET PROFIT	**1.30** **(6.87)**	**0.35**	**0.29** **(5.29)**	-	**0.34** **(12.73)**	-	**0.53**[1] **(2.52)**	-
IND. MILK PRICE	-0.06 (-0.08)	-0.02	-0.07 (-0.32)	-	0.05 (0.40)	-	**-0.89** **(-7.30)**	-
FLUID QUOTA PRICE	0.12 (1.69)	0.11	0.08 (1.62)	-	**0.72** **(6.27)**	-	0.41 (1.83)	-
INTEREST RATE(%)	-0.43 (-1.87)	-0.17	**-0.03** **(-2.68)**	-	0.01 (0.91)	-	0.01 (1.05)	-
OVER-QUOTA LEVY	0.11 (0.30)	0.03	-0.07 (-0.60)	-	**-0.22** **(-3.29)**	-	0.09 (0.99)	-

[1] There no net profit variable in the factorized model is; instead another quota asset, the price of Used MSQ, is used to explain the price of Unused MSQ.

Table A5.2: Used MSQ Results: Alberta

MODEL TYPE	MODEL 1a RESTRICTED MODEL		MODEL 1b LOGARIT. RESTICTED MODEL		MODEL 2a LOGARIT. ADAPTIVE MODEL		MODEL 2b LOGARIT. FACTORIZED MODEL	
	n= 23 R^2-ad.= 0.51 DW= -		n= 23 R^2-ad.= 0.48 DW= -		n= 23 R^2-ad.= 0.82 DW= (h) -1.06		n= 23 R^2-ad.= 0.93 DW= (h) -0.97	
ALBERTA	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**17.54** **(2.61)**	**0.95**	**2.72** **(3.73)**	-	-0.99 (-1.86)	-	**-1.10** **(-3.28)**	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.77** **(6.96)**	-	**0.47** **(6.12)**	-
NET PROFIT	0.30 (1.58)	0.11	0.06 (0.83)	-	**0.17** **(5.82)**	-	**0.52**[1] **(11.02)**	-
IND. MILK PRICE	-0.06 (-0.08)	-0.03	-0.06 (-0.19)	-	0.15 (0.99)	-	0.17 (1.80)	-
FLUID QUOTA PRICE	0.12 (1.69)	0.16	0.1 (1.58)	-	**0.31** **(7.80)**	-	**0.19** **(7.42)**	-
INTEREST RATE(%)	-0.44 (-1.87)	-0.24	**-0.03** **(-2.52)**	-	0.01 (1.52)	-	0.01 (1.68)	-
OVER-QUOTA LEVY	0.11 (0.30)	0.05	0.09 (0.64)	-	-0.06 (-0.80)	-	-0.05 (-1.06)	-

[1] There no net profit variable in the factorized model is; instead another quota asset, the price of Unused MSQ, is used to explain the price of Used MSQ.

Table A5.3: Fluid Quota Results: Ontario

MODEL TYPE	MODEL 1a		MODEL 1b		MODEL 2a	
	RESTRICTED MODEL		LOGARIT. RESTICTED MODEL		LOGARIT. ADAPTIVE MODEL	
	n= 133 R^2-ad.= 0.91 DW= -		n= 133 R^2-ad. = 0.93 DW= -		n= 133 R^2-ad.= 0.95 DW= 0.28	
ONTARIO	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	**25.46** **(4.60)**	**1.55**	**3.90** **(4.39)**	-	0.33 (1.60)	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.95** **(25.24)**	-
NET PROFIT	0.06 (1.83)	0.03	0.16 (1.30)	-	-0.01 (-0.63)	-
FLUID MILK PRICE	-0.56 (-1.51)	-0.44	-0.48 (-1.50)	-	0.07 (1.17)	-
USED MSQ PRICE	**0.20** **(3.95)**	**0.18**	**0.18** **(3.85)**	-	-0.05 (-1.70)	-
POLITICAL RISK	-0.05 (-1.92)	-0.18	**-0.01** **(-2.34)**	-	-0.04 (-1.77)	-
INTEREST RATE(%)	**-0.22** **(-2.51)**	**-0.18**	**-0.02** **(-3.09)**	-	**-0.01** **(-2.38)**	-

Table A5.4: Fluid Quota Results: Quebec

MODEL TYPE	MODEL 1a RESTRICTED MODEL		MODEL 1b LOGARIT. RESTICTED MODEL		MODEL 2a LOGARIT. ADAPTIVE MODEL	
	n= 53 R^2-ad.= 0.85 DW= -		n= 53 R^2-ad. = 0.87 DW= -		n= 53 R^2-ad.= 0.95 DW= -0.41	
QUEBEC	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	24.17 (1.84)	1.04	**3.43** **(2.50)**	-	0.16 (0.29)	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.86** **(3.40)**	-
NET PROFIT	1.18 (1.15)	0.11	0.05 (1.16)	-	**0.1** **(3.40)**	-
FLUID MILK PRICE	-0.19 (-0.21)	-0.10	-0.19 (-0.36)	-	0.16 (0.83)	-
USED MSQ PRICE	0.19 (1.77)	0.14	0.09 (1.57)	-	-0.08 (-1.73)	-
INTEREST RATE(%)	**-0.47** **(-2.40)**	**-0.21**	**-0.02** **(-2.54)**	-	**-0.01** **(-3.07)**	-
ASSESSMENT TAX 1	-0.28 (-1.11)	-0.01	0.00 (0.01)	-	0.01 (0.29)	-
ASSESSMENT TAX 2	1.98 (1.30)	0.02	0.08 (1.26)	-	0.03 (1.50)	-
CUSTA	-0.07 (-0.04)	-0.00	-0.02 (-0.22)	-	-0.07 (-0.17)	-
GATT	0.64 (0.46)	-0.00	0.03 (0.53)	-	0.04 (1.29)	-

Table A5.5: Fluid Quota Results: Alberta

MODEL TYPE	MODEL 1a RESTRICTED MODEL		MODEL 1b LOGARIT. RESTICTED MODEL		MODEL 2a LOGARIT. ADAPTIVE MODEL	
	n= 23 R^2-ad.= 0.78 DW= -		n= 23 R^2-ad.= 0.78 DW= -		n= 23 R^2-ad.= 0.84 DW= (h) 0.78	
ALBERTA	coeff (t-stat)	elast.	coeff (t-stat)	elast.	coeff (t-stat)	elast.
CONSTANT	21.71 (1.77)	0.91	**2.68** **(2.06)**	-	0.96 (0.92)	-
LAGGED DEP. VARIABLE	-	-	-	-	**0.10** **(3.21)**	-
NET PROFIT	-0.1 (-0.87)	-0.04	-0.00 (-0.75)	-	-0.04 (-1.15)	-
FLUID MILK PRICE	1.08 (1.04)	0.54	0.51 (0.97)	-	**0.77** **(2.06)**	-
USED QUOTA PRICE	**-0.18** **(-2.31)**	**-0.14**	**-0.14** **(-2.00)**	-	0.1 (1.11)	-
INTEREST RATE(%)	-0.44 (-1.87)	-0.19	-0.02 (-1.93)	-	**-0.02** **(-2.62)**	-