The Effects of Policy Changes on the Production and Sales of Milk in New South Wales

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Introduction

The dairy industry in New South Wales is highly regulated. Regional quotas on market milk have existed since 1938 and an individual quota scheme was introduced in 1955. The quotas were introduced to induce producers to supply milk year-round to ensure consumers an adequate supply of fresh milk. The existence of non-transferable quotas creates inefficiencies since quota holders must produce market milk at a given level all year-round and thus location and seasonal cost advantages cannot be obtained. Lower cost farms may be excluded from supplying market milk where firms with quota entitlement are able to produce milk at a marginal cost which is below the price of market milk but higher than the price of manufacturing milk which other producers are able to supply. The non–transferability of quotas raises the costs of production.

Increased competition from Victoria, where no quotas exist, and the introduction of a Closer Economic Relationship with New Zealand in July 1990 has led to a number of reforms within the New South Wales dairy industry. These include the introduction of negotiable quotas in July 1990, the incorporation of a market force component within the automatic price fixing mechanism contained in the Dairy Industry (Pricing) Regulation, the merging of a number of farmer co-operatives and the portability of quotas with vendors.

In this study the New South Wales Dairy industry is modelled using spatial equilibrium linear activity analysis in an attempt to examine potential policy effects on the production of market and manufacturing milk within different regions of New South Wales. The model is based on a subregional linear programming model developed by the Australian Bureau of Agricultural Economics (Williamson *et al.* 1988). In this study, ABARE's model is extended by adding milk demand functions and by creating a quadratic social welfare objective function to be maximized. The model can be used to examine the situation where quotas are totally removed from the New South Wales industry. The policies examined include fixed quotas (which are still relevant given the restrictions on quota transferability under the new system), negotiable quotas, and total deregulation.

In one version of the model, it is assumed demand for market milk is based solely in Sydney. Demand is assumed to be fixed and is thus independant of price. A second version of the model explores the case where demand also exists in other regions of the state, and the quantity of milk demanded is responsive to price. There are four demand centres;

(1) North Coast,

(2) Metropolitan (Sydney),

(3) Riverina,

(4) South Coast.

Each region is linked by a set of transportation activities. The model is also divided into four time periods enabling seasonality effects to be incorporated.

The spatial equilibrium linear activity analysis provides useful information for policy makers and dairy farmers alike. Production and sales levels of market and manufacturing milk in each region as well as the interregional transfers of market and manufacturing milk can be determined. The price of market milk in each region can be found. Details of aggregate transportation costs, production costs and resource usage levels, which may be of some use in other areas of study, are also produced, but are not examined in this study.

Spatial Equilibrium Analysis

A major development in spatial equilibrium modelling occurred with the publication of *Spatial and Temporal Price and Allocation Models* by Takayama and Judge (1971). This book provided an extensive foundation for the development and application of spatial equilibrium models through the use of quadratic programming (MacAulay, 1990).

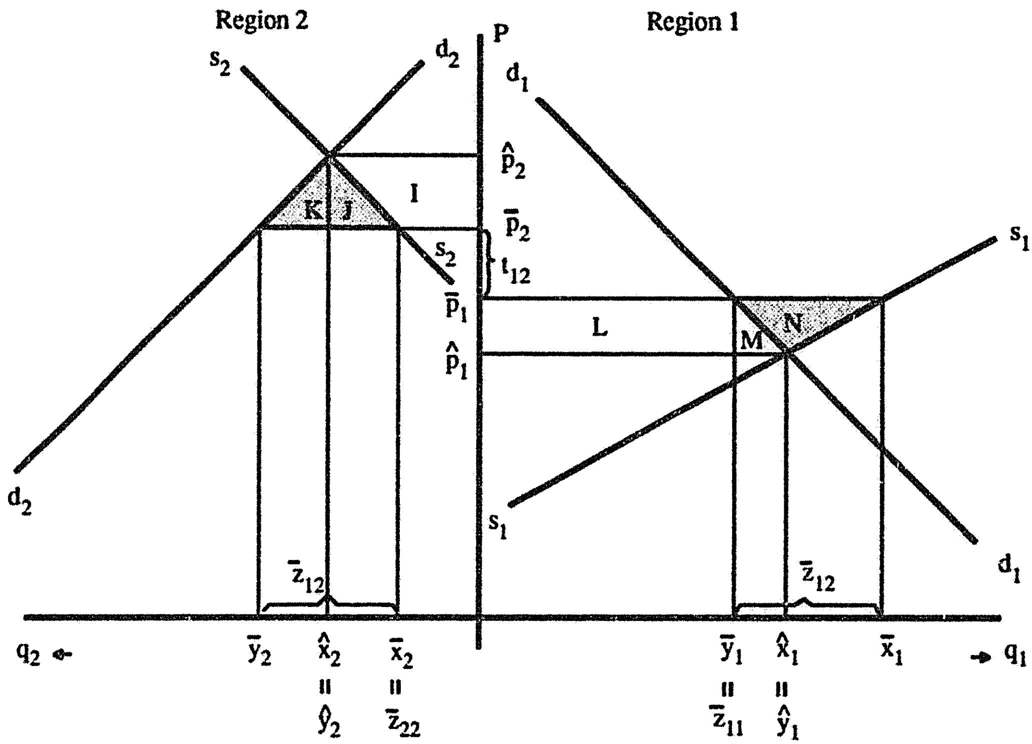
The spatial equilibrium problem arises where there are two or more regions with known supply and demand functions which produce and consume a homogenous product. The regions are separated but not isolated by known product transfer costs. Given these factors, the problem is to determine for each region the equilibrium levels of production, supply, consumption, prices and equilibrium trade flows betweeen regions (Martin, 1981).

Conditions of Exchange Equilibrium

A good which is mobile will move from the market where its value is lower to the market where its value is higher until differences of values are not larger than transportation costs. In other words, the price differences between any pair of regions cannot exceed transportation costs if the markets are to be in equilibrium. They must either differ by transportation costs (trade occurs), or be less than transport costs (no trade occurs). In the basic case where there are two regions, region 1 and region 2, and there is one homogeneous good (q), the price of good in region 1 which delivers the good to region 2 will be lower than the price in region 2 by the exact amount of the transportation cost from region 1 to region 2 if the markets are in equilibrium. The two region, one commodity case is represented in Figure 1.

Without interregional exchange the price in region 1 is $\hat{p}_1$ and in region 2 it is $\hat{p}_2$. If transportation costs are greater than $\hat{p}_2$ - $\hat{p}_1$ interregional exchange will not pay. At a transportation cost of $t_{12} < \hat{p}_2 - \hat{p}_1$ trade will be profitable. With exchange the price will rise in region 1 and fall in region 2. While the price difference is larger than transportation costs, traders will have a trading profit. This will vanish when price differences become equal to transportation costs. Then spatial equilibrium at prices $\bar{p}_1$ and $\bar{p}_2$ and an interregional exchange of $\bar{z}_{12}$ is reached. On the other hand, if the transport cost were to be so large as to exceed $\hat{p}_2 - \hat{p}_1$, no trade would occur, and the markets would be effectively isolated.

Figure 1 Back to Back Diagram of Interregional Trade



The autarkic position in Figure 1 is where prices equal $\hat{p}_1$ and $\hat{p}_2$ and the demand, y, and supply, x, of the given commodity will be $\hat{y}_1 = \hat{x}_1$ and $\hat{y}_2 = \hat{x}_2$ for region 1 and region 2. Autarky prices will prevail while no trade occurs between the two regions. If trade is allowed spatial equilibrium occurs at prices $\bar{p}_1$ and $\bar{p}_2$ as described above. Let z_{ij} denote the quantity produced in i and transported to j; $d_j(.)$ and $s_j(.)$ denote demand and supply functions in the jth region. The equilibrium relationship for traders among the quantities and prices are described as:

$$\bar{p}_2 - \bar{p}_1 - t_{12} \leq 0 ; \tag{1}$$

and

$$\bar{z}_{12} (\bar{p}_2 - \bar{p}_1 - t_{12}) = 0 \tag{2}$$

Equation 1 indicates that the prices in the two regions cannot be too different. Equation 2 indicates that if trade occurs, prices must differ by exactly the transport costs; or, if the price difference is less than the transportation costs, there must be no trade.

Producer and consumer equilibrium in the simple two region and one commodity trade problem yield the following:

$$\bar{p}_1 = d_1(z_1)$$

$$d_1(z_1) = s_1(z_{11} + z_{12})$$

$$\bar{p}_2 = d_2(z_{22} + z_{12}) \qquad (3)$$

$$d_2(z_{22} + z_{12}) = s_2(z_2)$$

Overall equilibrium is defined by (1), (2) and (3). Because of the inequality in (1), and the non-linearity of (2) these equations are not easy to solve. Suppose however that trade does occur, that is $z_{12} > 0$, then $\bar{p}_2 - \bar{p}_1 - t_{12} = 0$. Then the form equations of (3) plus the additional equality give a system of five equations in five unknowns.

$$\bar{p}_2 - \bar{p}_1 - t_{12} = 0$$

The five unknowns (p_1, p_2, z_{11}, z_{12}, z_{22}) are solved from the five equations simultaneously.

For two-regions, the nature of the equilibrium point is clear and it can be identified graphically, be it a case of trade from region 1 to 2 (as in Figure 1) or from region 2 to 1, or no trade. For multi-region problems, one has to resort to other solution methods. The descriptive equilibrium problem can be cast mathematically as an optimizing problem (Samuelson 1952, p 285), where the value of net social pay-off is maximized using quadratic programming. Takayama and Labys (1985) describe that this process begins by maximizing the sum of the producer and consumer surpluses less transportation costs given by equation 4. Where this is maximized, a spatial equilibrium solution is achieved.

$$\phi(y, x, z) = \sum_i \int_0^{y_i} d_i(\varepsilon_i)\, d\varepsilon_i - \sum_i \int_0^{x_i} S_i(\theta)\, d\theta_i - \sum_i \sum_j t_{ij} z_{ij}) \qquad (4)$$

Subject to;

$$\left.\begin{array}{l} y_1 - z_{1i} - z_{2i} - \dots\dots\dots\dots \leq 0 \\ -x_1 + z_{11} + z_{12} + \dots\dots\dots \leq 0 \end{array}\right\} \quad \text{for all } i \qquad (5)$$

and

$$\left.\begin{aligned} y &= (y_1, y_2, \ldots.) \geq 0 \\ x &= (x_1, x_2, \ldots.) \geq 0 \\ z &= (z_1, z_2, \ldots.) \geq 0 \end{aligned}\right\} \qquad (6)$$

where y is the demand for the commodity in each region, x is the supply of the commodity in each region, and z is the amount of the commodity transferred between producers and consumers. The function ϕ (y, x, z) represents the sum of consumers' and producers' surpluses with trade, less the trade costs. When the supply and demand functions are linear, the objective function reduces to a quadratic function and equilibrium exists where the function described by equation 4 is maximized. Martin (1981) shows this diagrammatically by maximizing the shaded areas in Figure 1. This can be seen via an examination of the gains and losses producers and consumers face resulting from the movement from an autarky point to the equilibrium position after trade. An examination of the effects in region 1 reveals the increase in price from $\hat{p}_1$ to $\bar{p}_1$ results in a net gain of N.

Producers gain	L + M + N	
Consumers lose	L + M	
Net gain	= N	(7)

Similarly, the effects in region 2 from a price decrease from $\hat{p}_2$ to $\bar{p}_2$ results in a net gain of area K + J which is determined in 8.

Consumers gain	K + J + I	
Producer lose	I	
Net gain	= K + J	(8)

The first and second order conditions for an optimum solution to this type of non-linear problem are known as the Kuhn-Tucker conditions. Provided the demand curve is not upwards sloping, and the supply curve is not downwards sloping, second order conditions are automatically satisfied. The first order conditions are direct extensions of the equations (1), (2) and (3). Further details on the Kuhn-Tucker conditions are given in Takayama and Labys (1985, p 8). The model can be extended to many regions, many products, and many time periods.

Regional supply functions for the New South Wales dairy industry

The ABARE subregional programming model was used to estimate the regional supply functions. Programming was used instead of econometric methods because regional supply data are not readily available. Secondly, linear programming is flexible enough to allow the incorporation of the complex linkages within a dairy farm.and thus provides a more effective method of estimating the supply function under alternative policies than econometric methods. The general method of estimating the supply function using programming methods is to vary the commodity price, using parametric programming, to produce a stepped supply function (see Blyth 1982, p. 141).

However, several problems must be considered when using the method. Stovall (1966, pp.477–480) lists these as specification error, sampling error and aggregation error. Specification error is essentially the difference between the real world situation and the model. Errors often occur in the technical coefficients, the resource constraints and the input and product prices used. Specification of the farmer's objective function and expectations may also be incorrectly modelled.

Sampling error is the difference between an estimate of a population parameter obtained from a sample and the population parameter itself (Neter, Wasserman and Whitmore 1982, p. 203). In linear programming studies, sampling error occurs in the initial stages when data is collected from a sample of farms.

Aggregation error is the difference between the supply response gained from the summation of linear programming solutions for each of the individual dairy farms in the industry and that attained from the programming and weighted summation of supply responses for a smaller representative number of farms (Blyth 1982, p. 162). For the representative farm model approach, the aggregate supply estimate is arrived at by appropriately weighting the representative farm solution vector according to the number of farms in the region. If the aggregate supply estimated in this method is different to that where each individual farm was included then aggregation error is a problem. The method of selecting representative farms is therefore very important. The ABARE subregional programming model divides the state into four main regions and three farm types in each region using data provided by the 1984–1985 and 1985–1986 Dairy Industry Survey data.

The three different farm types are defined as follows. Type 1 farms are "quota" farms producing a high proportion of market milk, and a low proportion of manufacturing milk and characterised by high feed and high total costs. Type 2 farms tend to have a seasonal pattern of production producing less milk in winter months than the other farms, but have some comparative advantage in the production of winter milk. Type 3 farms are the extreme, having a much more seasonal pattern of production with less milk in winter and more in late spring, summer and early autumn.

The ABARE subregional programming model can be summarised into five different parts

(1) eleven subregional technology matrixes (one farm type in each region, less a type 1 farm in the Riverina (region 3);

(2) a market milk revenue submatrix, which is constrained by equalities to supply a specific amount of market milk to Sydney;

(3) a transport submatrix, which includes the cost of transporting market milk to Sydney, and manufacturing milk in other regions;

(4) four manufacturing milk revenue submatrixes which are constrained by regional demand curve quantities that vary temporally in accordance with historical trends;

(5) an accounting submatrix to provide convenient access to aggregate cost and production data.

(Williamson, *et al* 1988, p. 6)

The marginal cost of milk production is largely determined by feed supplies during different times of the year (Hill and Freshwater 1988, p. 35). For this reason the year has been divided into four periods which were designed to reflect as accurately as possible the seasonality of pasture growth in New South Wales.

Demand for market milk in New South Wales

Market milk has relatively few uses, a small number of substitutes and represents a small proportion of most families income (Bewley 1990, p. 97) and therefore is expected to have a relatively inelastic demand curve. Studies undertaken by Ratnam and Speilman (1972), Street (1974), Nelson (1977) and others shown in Table 1, show the relatively inelastic demand for market milk in New South Wales, Australia and overseas.

A major problem in determining the own-price elasticity of demand for the New South Wales market milk sector is that prices have been regulated according to a specific price fixing formula under the Dairy Industry (Pricing) Regulation with restrictions on output set by supply quotas. Davidson, MacAulay and Powell (1989, p. 10) indicate that this causes a problem in relation to using time series data for the estimation of a market milk demand equation. They argue that the problem arises in identifying statistically significant variables which show the correct sign. They also point to the additional problems of multicollinearity and autocorrelation. Since regulation affects the given prices and quantities of market milk in New South Wales, Bewley (1990) attempted to estimate the price elasticity of market milk demand based on cross–sectional data rather than time–series data. Basing his demand equation on own price, income, population and age structure he derived an own-price elasticity of demand for market milk of – 0.13.

Table 1 Elasticities of market milk determined in previous ptudies

Study	Location	Factors influencing demand	Own-Price elasticity of demand
Ratnam & Speilman (1972)	Hawaii	Household size, habit, acceptability, and own price	Inelastic
Street (1977)	Sydney	Price, age distribution, lagged milk prices	– 0.2
Nelson (1977)	New South Wales	Price and age, distribution	Inelastic
	& Queensland		Inelastic
Tedesco (1979)	New South Wales	Price, population, and seasonal factors	Inelastic
Collins (1981)	Australia	Price, income, age, seasonal factors	Inelastic
Bewley (1987)	New South Wales & Victoria	Price and income	– 0.1
Davidson, MacAulay & Powell (1989)	New South Wales, Victoria & Queensland	Own price, income, and cross prices	NSW – 0.00 VIC – 0.28 QLD – 0.00
Bewley (1990)	New South Wales	Price, income, population, and age structure	– 0.13

Derivation of an Aggregate Demand Equation

The market milk demand equation used in the spatial equilibrium problem is based on Bewley's elasticity figure of – 0.13. Assuming that the retail demand equation for market milk is linear, it may be derived if the quantity of market milk consumed by New South Wales consumers at any time and the retail price of market milk at that time are known. For the purposes of this study it is assumed that a typical quantity of market milk demanded by consumers in New South Wales is 393,054,800 litres (see Williamson, Topp and Lembit, 1989), and that this quantity is consumed at a retail price of 85c per litre. This is the going price consumers paid in October 1989 (New South Wales Dairy Corporation 1990, p. 58). The demand function is

$$P = 7.38846154 - 6.6539949 \times 10^{-8} Q \qquad (9)$$

where Q is quantity in litres per quarter, and P is price in dollars per litre.

A farm level demand rather than retail demand equation is required since there are marketing margins between the price farmers receive and the price consumers pay for a good. If the marketing margins are assumed to be constant and total 43.82 cents per litre, the derived demand for market milk can be found be subtracting 43.82 cents per litre from the constant in Equation 9.

$$P = 6.9502615 - 6.6539949 \times 10^{-8} Q \qquad (10)$$

To be consistent with the scaling factors used in the ABARE model the demand function is re-expressed in units of 10^7 litres.

$$P = 6.9502615 - 6.6539949 \times 10^{-1} Q \qquad (11)$$

Equation 11 represents the total farm level demand equation for market milk per quarter in New South Wales. This is used in the quadratic programming (single demand) region model.

The Models

Incorporation of demand in ABARE's subregional programming model [Model A]

In this case the demand equation is perfectly inelastic since the price received for each litre of market milk sold to Sydney is 41.18 cents per litre while output is forced to remain constant under a fixed quota. The price of market milk is exogenously fixed. With demand fixed, consumer surplus is constant, and the equilibrium is defined by the solution to a cost minimizing linear programming model.

A linear programming profit maximization model which aims to find the competitive equilibrium pattern of production is reasonable only where retail prices (and farm prices) are fixed. Since prices are not fixed in a deregulated market, and demand is linear and neither perfectly elastic or perfectly inelastic, a quadratic programming model such as that described by Samuelson (1952) is required.

Incorporation of demand in the quadratic programming (multiple demand) regions model [MODEL B]

In this model, demand functions are added. Thus as the quantities of market milk sold varies, so does the price. In Model B, each of the four regions has a given demand for market milk in each quarter. In estimating the demand for market milk in each region, census statistics were used to disaggregate total demand into four regional demand equations. The population of each region was taken from Australian Bureau of Statistics (1990) data. The aggregate market milk demand curve is simply the horizontal summation of the individual market milk demand curves for each of the regions. Assuming all consumers have the same demand function, then each region's market milk demand curve can be found by dividing the slope coefficient of the aggregate market milk demand curve by the proportion of the population in that region.

Thus the quarterly market milk demands for each region are given by:

North Coast	$P = 6.9502615 - 6.926865\ Q$	(12)
Metropolitan	$P = 6.9502615 - 0.8585057\ Q$	(13)
Riverina	$P = 6.9502615 - 14.944201\ Q$	(14)
South Coast	$P = 6.9502615 - 7.888881\ Q$	(15)

The slope coefficients, for example – 6.926865 for the North Coast quarterly aggregate demand function, are entered as the quadratic coefficient in the objective function of the quadratic programming model. The intercepts of the demand function 6.9502615 provides the linear part of the objective function. An additional 12 sell market milk activities were incorporated into the model to allow for the expanded number of demand regions. An additional 12 aggregate market milk pools were also required.Thus Model B has 16 demand equations which are incorporated into the model through the 16 regional market milk sell activities.

Since each region can sell its market milk in any of the 4 regions (which includes selling to its own region), an additional market milk transportation sub-matrix was built. In Model A only, the cost of transporting market milk to Sydney alone from each of the 4 regions was considered. An additional 12 transportation activities were required to enable market milk to be transported between each of the 4 regions. To facilitate policy analysis, the accounting sub-matrix was also enlarged to enable total transport costs for each route to be summed.

The transportation costs for transporting market and manufacturing milk were assumed to be the same since both require the same transport and handling procedures. Table 2 gives the interregional transportation costs.

Table 2 Interregional Transportation Costs

Region	Transportation Cost ($ per litre)
North Coast to Metropolitan	0.0425
Metropolitan to Metropolitan	0.01
Riverina to Metropolitan	0.0645
South Coast to Metropolitan	0.026
North Coast to North Coast	0.015
Metropolitan to North Coast	0.0425
Riverina to North Coast	0.085
South Coast to North Coast	0.051
North Coast to Riverina	0.085
Metropolitan to Riverina	0.0645
Riverina to Riverina	0.011
South Coast to Riverina	0.051
North Coast to South Coast	0.055
Metropolitan to South Coast	0.026
Riverina to South Coast	0.051
South Coast to South Coast	0.012

Demand for Manufacturing Milk in New South Wales

The demand for manufacturing milk has the same structure in both models. Manufacturing milk can be transferred between regions, at the same cost as for market milk. The demand for manufacturing milk is assumed to be perfectly elastic based on the notion that manufacturing milk faces world prices and Australia is a relatively small producer of dairy products.

The manufacturing milk prices enter all three models directly under each farm's sell manufacturing milk activity. The manufacturing milk prices for each region are given in Table 3. These values were used in ABARE's model and were not changed for Model B.

Table 3 Manufacturing Milk Prices

Region	Price ($ per litre)
North Coast	0.2163
Metrololitan	0.2102
Riverina	0.1748
South Coast	0.2081

Model Results

The results derived included the market and manufacturing milk production levels for each region, the quantity of market milk sold in each region, the quantity of market milk sold in each period, the price of market milk in each of the regions at the time in which it was sold, the market milk transfers between regions (Model B), and the manufacturing milk transfers between the regions. The model also generates details of the activity levels for each of the representative farms and by virtue of the accounting matrix, aggregate regional and industry costs can also be examined in relation to given policy changes. None of this data is reported in this paper, but is available from the authors on request. The policies were examined under each of the 3 major models and are outlined in Table 4

Table 4 Model identification by policy implemented

	Quota		Deregulation	
	Fixed	Negotiable	Partial	Total
MODEL A (Single demand region linear program)	LPFQ	LPNQ		
MODEL B (Regional demand quadratic program)	QPFQRD	QPNQRD	QPPDRD	QPTDRD

Effects on Market Milk Production

The specific results of Model B on the production of market milk under the fixed quotas, negotiable quotas and deregulation policy alternatives are reported in Table 5. Partial deregulation is not examined since it has little policy application.

With the introduction of negotiable quotas, the results indicate that the major change is a shift in production from the North Coast to the Metropolitan region. There is a similar, but smaller shift, from the Riverina to the Metropolitan region. It is likely that the strong demand for market milk in the Metropolitan region and the relatively high transportation costs between regions contributes to these changes. Under a negotiable regime, production moves to areas which are the most efficient, that is, where the marginal costs of production are the lowest. This reallocation of production between regions improves efficiency.

Table 5 Changes in Market Milk Production

	Units	Volume	Change from Fixed Quota	Change as a percentage	Change fromNegotiable to Deregulated (%)	State Production (%)
North Coast						
Fixed quotas	10 ML	9.94787				25.3
Negotiable quotas	10 ML	3.77138	- 6.1765	- 62.09		9.6
Deregulation	10 ML	3.8718	- 6.0761	- 61.08	1.01	9.6
Metropolitan						
Fixed quotas	10 ML	15.43942				39.3
Negotiable quotas	10 ML	23.41211	7.9727	51.64		59.6
Deregulation	10 ML	23.82983	8.3904	54.34	2.71	59.1
Riverina						
Fixed quotas	10 ML	2.31046				5.9
Negotiable quotas	10 ML	1.76078	- 0.5497	- 23.79		4.5
Deregulation	10 ML	1.80733	- 0.5031	- 21.78	2.01	4.5
South Coast						
Fixed quotas	10 ML	11.60772				29.5
Negotiable quotas	10 ML	10.3612	- 1.2465	- 10.74		26.4
Deregulation	10 ML	10.84193	- 0.7658	- 6.60	4.14	26.9

Under total deregulation, there will be little further relocation of production beyond that for negotiable quotas, since the most efficient regions are then producing. The major change that will occur will be an increase in the level of market milk production until economic rents associated with the quota are eroded away, that is, until the prices for market milk fall to a level where marginal costs equal marginal revenue. The model results indicate that market milk production increases under deregulation and that little further regional production redistributions occur. Levels of market milk production in each region under deregulation are up to 4 percent higher than the negotiable policy case.

Effects on Manufacturing Milk Production

Manufacturing milk production levels are not directly affected by market milk quotas, except to the extent that a fixed surplus amount should be produced to prevent under supply of quota requirement. However, the results (reported in Table 6) indicate that manufacturing milk production levels are affected indirectly in that where a region increases its market milk production the quantity of manufacturing milk produced in that region will decline, more or less maintaining total milk production. Again the major result is that more manufacturing milk will be produced on the North Coast and the Riverina, and less in the Metropolitan region.

Table 6 Changes in Manufacturing Milk Production

	Units	Volume	Change from Fixed Quota	Change as a percentage	Change fromNegotiable to Deregulated (%)	State Production (%)
North Coast						
Fixed quotas	10 ML	10.46059				23.0
Negotiable quotas	10 ML	14.01385	3.5533	33.97		32.8
Deregulation	10 ML	13.91342	3.4528	33.01	– 0.96	33.7
Metropolitan						
Fixed quotas	10 ML	15.08263				33.1
Negotiable quotas	10 ML	7.10994	– 7.9727	– 52.86		16.6
Deregulation	10 ML	6.69222	– 8.3904	– 55.63	– 2.77	16.2
Riverina						
Fixed quotas	10 ML	7.15705				15.7
Negotiable quotas	10 ML	7.80713	0.6501	9.08		18.3
Deregulation	10 ML	7.76058	0.6035	8.43	– 0.65	18.8
South Coast						
Fixed quotas	10 ML	12.82361				28.2
Negotiable quotas	10 ML	13.78851	0.9649	7.52		32.3
Deregulation	10 ML	12.9073	0.0837	0.65	– 6.87	31.3

If total deregulation were to occur, a reduction in the production of manufacturing milk occurs in all regions. These reductions are only minor in the North Coast and Riverina and are most substantial for the South Coast.

Effects on Total Milk Production

The total level of milk production for each region is reported in Table 7. Generally total milk production in each region remains similar under each policy with the main exception being the North Coast.

Table 7 Changes in Total Milk Production

	Units	Volume	Change from Fixed Quota	Change as a percentage	Change fromNegotiable to Deregulated (%)	State Production (%)
North Coast					%	
Fixed quotas	10 ML	20.40846				24.1
Negotiable quotas	10 ML	17.78523	– 2.6232	– 12.85		21.7
Deregulation	10 ML	17.78522	– 2.6232	– 12.85	0.00	21.8
Metropolitan						
Fixed quotas	10 ML	30.52205				36.0
Negotiable quotas	10 ML	30.52205	0.0000	0.00		37.2
Deregulation	10 ML	30.52205	0.0000	0.00	0.00	37.4
Riverina						
Fixed quotas	10 ML	9.46751				11.2
Negotiable quotas	10 ML	9.56791	0.1004	1.06		11.7
Deregulation	10 ML	9.56791	0.1004	1.06	0.00	11.7
South Coast						
Fixed quotas	10 ML	24.43133				28.8
Negotiable quotas	10 ML	24.14971	– 0.2816	– 1.15		29.4
Deregulation	10 ML	23.74923	– 0.6821	– 2.79	– 1.64	29.1

Changes in Market Milk Prices

Prices are determined by the quantities of market milk sold in each region, in each time period. Table 8 indicates the percentage changes in price of market milk for each policy scenario using fixed quota prices as the base. Price changes are reported for each period.In summary, the results show that the fixed quota policy and negotiable quota policies hold the price of market milk at higher levels than the deregulated market due to supply restrictions.

Table 8 Policy effects on the Prices of Market Milk

	Fixed Quotas	Negotiable Quotas	% change Fixed to Negotiable	Total Deregulation	Price change from Fixed to Total Deregulation	% change Fixed to Deregulated
Jan-March Metropolitan	$0.418	$0.413	– 1.32	$0.233	$0.185	44.21
Apr-June Metropolitan	$0.418	$0.415	– 0.77	$0.244	$0.175	41.75
July-Sept Metropolitan	$0.418	$0.416	– 0.53	$0.250	$0.168	40.17
Oct-Dec Metropolitan	$0.418	$0.413	– 1.32	$0.233	$0.185	44.21
Jan-March North Coast	$0.391	$0.425	8.76	$0.245	$0.145	37.16
Apr-June North Coast	$0.391	$0.417	6.71	$0.245	$0.145	37.16
July-Sept North Coast	$0.391	$0.411	5.28	$0.245	$0.145	37.16
Oct-Dec North Coast	$0.391	$0.425	8.76	$0.245	$0.145	37.16
Jan-March Riverina	$0.365	$0.377	3.54	$0.198	$0.167	45.68
Apr-June Riverina	$0.365	$0.369	1.32	$0.198	$0.167	45.68
July-Sept Riverina	$0.365	$0.364	– 0.25	$0.198	$0.167	45.68
Oct-Dec Riverina	$0.365	$0.377	3.54	$0.198	$0.167	45.68
Jan-March South Coast	$0.404	$0.409	1.19	$0.230	$0.175	43.19
Apr-June South Coast	$0.404	$0.401	– 0.79	$0.230	$0.175	43.19
July-Sept South Coast	$0.404	$0.402	– 0.54	$0.236	$0.168	41.58
Oct-Dec South Coast	$0.404	$0.409	1.19	$0.230	$0.175	43.19

Comparison of Objective Values

Negotiable quotas and deregulation are likely to lead to an improvement in efficiency. Lembit and Bhati (1987) found that the restrictive production policies employed by the New South Wales dairy industry led to higher farm costs. The study carried out by Williamson, Topp, Lembit and Beare (1988) found that the system of non–negotiable quotas created inefficiencies to the extent that each dairy farm would be 'given' a payment of $1000 from the industry as a direct result of the introduction of a negotiable quota scheme. Studies by the Industry Assistance Commission (1983) and Purtill and Skinner (1987) have also highlighted some of the inefficiencies inherent in the dairy marketing system.

The objective function in each of the quadratic programming models developed in this study relate to a level of social welfare. Optimal solutions are found where this measure of social welfare is maximized. By examining the changes in the objective values obtained under each model an indication of the optimal policy in relation to social welfare may be determined. The differing objective values under each policy are given in Table 9.

Table 9 Objective Values for Each Policy Modelled

Fixed quotas [QPFQRD]	$\$1.39504 \times 10^2$
Negotiable quotas [QPNQRD]	$\$1.39888 \times 10^2$
Total deregulation [QPTDRD]	$\$1.39979 \times 10^2$

Social welfare levels are greatest under the totally deregulated policy model which is consistent with economic theory. The increase in the objective value is greater for the movement from fixed to negotiable quotas than it is for the movement from negotiable quotas to total deregulation. The changes in the production of market milk between regions can be directly related to the improvement in the objective function since greater adjustments in regional production of market milk and manufacturing milk occurred in the first policy change. Relocation of market and manufacturing milk production under a freer environment is thus the main cause of the gains. This occurs because farmers with lower costs of production and advantages in relation to market locality are able to produce more market milk. The model results are therefore consistent with previous expectations that the removal of fixed quotas would improve efficiency.

The actual direction of change in the production of market milk has however been contrary to the results obtained from previous work, for example ABARE's work in 1988. In this study market milk production increases dramatically in the Metropolitan region while large reductions have occurred in the North Coast with both the introduction of negotiable quotas and total deregulation. The Riverina was found not to be a major producer of market milk under either the negotiable quota scenario or total deregulation which seems realistic given its distance from the major market in Sydney.

Areas of Further Research

The implications of supply from other than New South Wales regions have not been considered in this analysis. Under the negotiable quota system which is presently in place, prices of market milk in New South Wales are much higher and thus Victorian supplies to the Sydney market may be competitive. An additional region 'Victoria' is required in the model to consider this possiblity. In the case of deregulation, Victorian imports are unlikely to replace New South Wales production since it seems to pay the latter to produce even at the low manufacturing prices.

Manufacturing milk prices determine production at the margin. Hence the demand function for manufacturing milk is very important, under deregulation in particular. Some form of demand equation for manufacturing milk should be incorporated into the model. It may be useful also to incorporate the processing sector into the model if its effects on manufacturing milk prices were important enough. Rational location of processing factories may be an extended policy analysis under such a model.

The quadratic program could be adjusted so that the assumption of constant per unit costs of transformation are relaxed allowing the average cost curves of transformation to be specified in a quadratic nature creating a cubic programming model. MacAulay, Batterham and Fisher (1989) describe the usefulness of cubic programming methods in spatial trading systems. The spatial trading system of the New South Wales dairy industry may give a practical application to such advances in mathematical programming.

The data used in the model could be examined in more detail and updated further. Policy effects on the farm level could be analysed to give an indication of the kinds of resource useage levels and cost variations that would occur. The results for this work could be found directly in the solutions already obtained under this study. All that is required is that the policy analysis be on a less aggregated basis, examining the input rather than output solutions obtained. The advantage of the programming model used is that it has the ability to give the optimal input levels required for each representative farm.

Some form of sensitivity analysis should also be undertaken. Given the reliance on fixed prices for manufacturing milk in each region and on the fixed transportation costs of milk between regions, the model needs to be examined for stability in its solution given a range of prices and costs. Some sensitivity analysis was undertaken on the cost of transporting milk from the Riverina to check the validity of the results given that the Riverina had a much smaller significance in this study than in other studies. From the limited number of sensitivity runs undertaken, it was found that practically no changes to the result occurred for the first one cent per litre drop in transportation costs from the Riverina to Sydney. A more extensive study is needed to confirm the stability of this solution.

Conclusions

The general effect of negotiability and deregulation on the production of market, manufacturing and total milk production is significant and can be observed readily within Tables 5 to 9. Essentially the North Coast will produce much less market milk while the Metropolitan region will increase its production significantly under both negotiable quotas and deregulation. The major effect deregulation has in addition to the policy of negotiable quotas is that large falls in prices will occur in all regions. The price decline will far outweigh the additional production of market milk and farm revenues will decline.

Manufacturing milk production levels adjust such that total milk production levels essentially remain unchanged for each region. Since production is restricted to a level where marginal costs equal marginal revenue, and that marginal revenue is set by the price of manufacturing milk, changes in total production will not occur under deregulation. This explains the large reductions in manufacturing milk production in the Metropolitan region as more market milk is produced under both negotiable quotas and deregulation. Large increases in the production of manufacturing milk will occur in the North Coast but total production of milk will decline in that region.

Contrary to the study carried out by ABARE (Williamson, Topp, Lembit and Beare, 1988), and to some other market participants beliefs (dairy farmers comments), the Riverina seems to have a very small part to play in the production of market milk for consumption in New South Wales. This indicates also that distance to market plays an important role and that as such Victoria may not be able to compete with producers in New South Wales. If this is the case for the negotiable quota scenario, where prices are relatively high, it will be more pronounced if total deregulation occurs, since prices will be much lower.

The movement in New South Wales to a policy of negotiable quotas should increase efficiency in the industry. Deregulation will take producers to an even more competitive position but it will have detrimental effects on producers income levels. Farmers should therefore argue against total deregulation. Consumers however should argue for deregulation, since they will benefit from lower prices.

The model has given detailed information on the effects negotiable quotas and deregulation will have on production of market and manufacturing milk in each of the four regions described. It has given the market milk sales and prices in each region and therefore has fulfilled its objective of providing a framework for analysing the effects of different policies on the New South Wales dairy industry.

List of references

Australian Bureau of Statistics (1990), 'Estimated Resident Population of Statistical Local Areas of NSW, At 30 June, 1988 Final and 1989 Preliminary', Catalogue No. 3210.1, Canberra.

Bewley, R. (1987), 'The demand for milk in Australia', Estimation of price and income effects from the 1984 household expenditure survey', *Australian Journal of Agricultural Economics*, 31(3) 204-18.

______(1990), Price Elasticity of Market Milk Demand in NSW. Unpublished Research Report.

Blyth, M.J. (1982), A spatial equilibrium linear activity analysis of the New South Wales dairy industry. Unpublished Ph.D. thesis, University of Sydney.

Collins, D.J. (1981), 'An analysis of the demand for fluid milk in Queensland'. Diploma of Business Administration Dissertation, Queensland Institute of Technology, Brisbane.

Davidson, B., MacAulay, G. and Powell, R. (1989), 'The estimation of the demand for market milk, cheese and butter in New South Wales, Victoria and Queensland', *Dairy Economics Research Report No.2*, University of New England.

Hill, C., Freshwater, R. (1988), Report on The Cost of Milk Production in New South Wales, 1986 / 87, Paper 12.3, New South Wales Dairy Corporation.

Industries Assistance Commission (1983), *The Dairy Industry*, Report 333, AGPS Canberra.

Lembit, M. and Bhati, U.N. (1987), 'Farm cost effects of dairy policies in New South Wales and Victoria', *Review of Marketing and Agricultural Economics*, 55(3), 201-12.

MacAulay, T.G. (1990), 'Alternative Spatial Equilibrium Formulations: A Synthesis' University of New England, (In press).

MacAulay, T.G., Batterham, R.L. and Fisher, B.S. (1989), 'Solution of spatial trading systems with concave cubic programming'. *Australian Journal of Agricultural Economics*. 33(3) 107-202.

Martin, L.J. (1981), 'Quadratic single and multi-commodity models of spatial equilibrium : a simplified exposition', *Canadian Journal of Agricultural Economics*, 29 (1), 21-48.

Nelson, P. (1977), 'Demand model for fluid milk', Quarterly Review of Agricultural Economics, 29(3) 341-52.

New South Wales Dairy Corporation (1990), *New South Wales Dairy Industry Statistics*.

Purtill, A. and Skinner, S. (1987), Import parity pricing arrangements for the Australian dairy industry. Paper presented to the Australian Agricultural Economics Society Conference, Adelaide, 10 - 12 February.

Ratnam, N.U. and Spielmand, H. (1972), 'Consumer attitudes and their impact on fluid milk demand in Hawaii. A component regression analysis approach; *American Journal of Agricultural Economics*, 54(4) 671-78.

Samuelson, P.A. (1952), 'Spatial price equilibrium and linear programming', *American Economic Review* 42 (3), 283-303.

Stovall, J.G. (1966), 'Sources of error in aggregate supply estimates', *Journal of Farm Economics*, 48 (2) 477-80.

Street, T.A. (1974), 'Demand for milk', Review of Marketing and Agricultural Economics, 42 (2) 100-13.

Takayama, T. and Labys, W.C. (1985) Spatial Equilibrium Analysis, Discussion Paper 85.11, University of Western Australia.

Tankayama, T. and Judge, G.G. (1971), *Spatial and Temporal Price and Allocation models*, North–Holland Publishing Co, Amsterdam.

Tedesco, R. (1979), 'The factors influencing the demand for wholemilk in New South Wales, Master of Science (Agriculture) thesis, University of Sydney.

Williamson, G., Topp, V., Lembit, M. and Beare, S. (1988), Quota regulations and economic efficiency in the New South Wales dairy industry: a programming evaluation. Paper presented at the Australian Economics Congress, Canberra, 28 Aug - 2 September.

Williamson, G., Topp, V.and Lembit, M. (1988), A subregional linear programming model of the NSW dairy industry: Technical Documentation. Paper presented at the Australian Economics Congress, Canberra, 28 Aug - 2 September.