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Regulating and deregulating the dairy industry

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1. Introduction

The Australian dairy industry is one of the most highly regulated agricultural industries in Australia. The system of producing, processing, distributing and pricing dairy products has evolved over time as a result of factors such as: the physical characteristics of milk and milk products; the nature of technical change in production, processing and transportation; the policies of State and Commonwealth Governments; and the extraordinarily successful lobbying power of the dairy industry.

This paper contains a brief account of the current policies in the dairy industry and considers the pressures that will shape the industry in the future. We have used a spatial equilibrium model developed by Bardsley, Daniel and Wilcox (1992) to document the economic costs of current policies and to examine the impact of policy changes on the dairy industry. This model includes a detailed specification of dairy policies but the parameter settings and patterns of trade are determined endogenously[1]. This flexibility allows us to examine partial and staged deregulation (as was recommended by the Industry Commission (1991) and accepted by the government, albeit more gradually). We examine the pattern of interstate rivalry and the incentives to break out of the regulatory framework that could be expected under various deregulatory scenarios. An important finding is that the deregulatory pathway recommended by the Industry Commission may create incentives for perverse and inefficient patterns of interstate trade, which we expect would lead to a renegotiation of policy.

2. The Australian dairy industry

The size and structure of the Australian dairy industry have changed significantly over time. The number of dairy farmers has rapidly declined from 117,000 in 1960 to 14,958 in 1991; farm size has more than doubled over the same period while total production has stayed reasonably constant at about 6000 ML for the past forty years, varying cyclically between 7,500 and 5,200 over the period. The gross value of production of the industry has risen to over $1.9 billion.

Fifty years ago, Australia had two dairy industries. Dairy farmers producing market milk were located close to the cities and towns they supplied while farmers remote from large towns and cities mainly supplied cream to local butter factories. Market milk had to be produced close to cities because technology was not available to store it for long periods or to transport it long distances. State Governments, in whom the Australian Constitution vests responsibility for health matters, set strict standards for all stages of production, processing and distribution of market milk. Governments believed that milk was an essential foodstuff and that supply must be assured throughout the year, therefore, all aspects of production and distribution became highly regulated and closely supervised. Producing high quality milk consistently throughout the year was costly so dairy farmers producing market milk received a higher price for their milk than their counterparts producing cream for butter factories. Most State Governments used some form of quota scheme to ensure continuous supply throughout the year.

Farmers producing milk for manufacturing purposes did not have to maintain the same standard of hygiene required for fresh milk and seasonality of supply was not as

[1]For example, our model determines endogenously which States are net exporters under the free trade regime, with prices linked to export parity, and which are not. There is no assumption that export parity applies to all.

important. Until the mid to late 1950s milk for manufacturing was neither kept refrigerated on farms nor transported to factories in bulk milk tankers. As production, handling and processing technology changed, all milk came to be stored in refrigerated vats on farms and collected in efficient, hygienic, insulated bulk milk tankers. These developments, combined with better production techniques have improved the quality of all milk to the point where nearly all manufacturing milk is of a sufficiently high standard to be used for fresh consumption.

2.1 The market milk sector

The market milk (liquid milk) sector of the dairy industry is controlled by separate legislation in each of the six States. Each State controls prices at all stages of production, marketing, and transportation as well as the mechanisms for allowing access to the high-priced fresh milk market. Many policies used to regulate the supply and price of market milk are vestiges of legislation designed to protect human health or ensure continuity of supply. However, technological progress and changing consumer requirements have mostly made the original justification for government intervention obsolete. Human health has always been an influential factor in determining the type of regulations governing the supply of market milk. Before the development of pasteurisation, tuberculosis spread in Australia mainly via fresh milk (Evans, Johnston and Butterworth 1974). Controlling disease and safeguarding health is the constitutional responsibility of the States as is the regulation of pricing and manufacturing. Therefore, the regulation of market milk is controlled by separate legislation in each State.

Another important influence on market milk legislation has been the problem of variable supply throughout the year. This is less of a problem today because milk can be more cheaply and readily transported to even out supply variations. Quota schemes were established in five of the six States to ensure continuity of supply for consumers. Even then, the schemes existed partly for political reasons and to look after groups of dairy farmers. Parish and Kerdpibule (1968) showed that there were more efficient alternatives to the New South Wales quota scheme.

Improvements in technology (such as pasteurisation, refrigeration, packaging and transport) mean that human health can be protected and supply can be guaranteed without the stringent distribution, pricing and quota arrangements of the past. All that is needed is a set of regulations that ensures that milk is pasteurised and meets certain hygiene and quality standards. Nevertheless, the legislative framework developed to deal with these problems remains and is used by the dairy industry to maintain the price of market milk at a premium above the free market price — the market milk premium. Price support has been an objective of dairy marketing schemes since they were first introduced during the 1920s and 1930s. During the depression of the 1930s, prices fell substantially and farmers successfully lobbied for assistance. Price support is now the only reason for the continuing legislated distinction between market milk and manufacturing milk. Table 1 summarises the mechanisms used by each of the States in regulating market milk.

In each case, the regulations summarised in table 1 aim to protect the market milk premium through *intrastate regulations* which restrict the amount of milk that can be sold as market milk within each State; and through *interstate regulations* which limit the extent to which manufactured milk produced in other States can be sold as market milk.

Sometimes, *intrastate* regulations take the form of quotas that can be sold to other dairy farmers in the same State or region. Other quotas cannot be traded: they must remain

Table 1 Summary of state market milk controls

State	*Policies*
Vic	Pooling of market milk and manufacturing returns. All farmers receive a proportional share of the premium. Retail and farm-gate prices are fixed.
NSW	Quotas for market milk supply. Quotas have been tradeable since July 1990 but there are restrictions on eligibility to purchase them. Retail and farm-gate prices are fixed.
Qld	Most milk is produced in the south-east where there are entitlements (quotas) to supply milk. Quotas operate in central Queensland while on the Atherton Tableland there is a pooling arrangement. Retail and farm-gate prices are fixed.
SA	Three quarters of South Australia's milk is produced near Adelaide under a scheme that pays farmers an average of market milk and manufacturing returns. Farmers in the south-east receive a payment from the metropolitan supply area to compensate them for lack of access to the fresh milk market. Metropolitan farm-gate and retail prices are fixed.
WA	Tradeable quotas for market milk with a maximum on the quota held by any individual farmer. Fixed farm-gate price for milk. The retail price has been deregulated.
Tas.	Pooling of market milk and manufacturing milk returns. All farmers share in the market milk premium. Fixed retail and farm-gate prices.

with an individual or farm. A premium is paid for the supply of the assigned quota of milk. Additional production beyond the quota attracts the much lower manufacturing price. In other States, a central authority regulates the distribution of the market milk premium directly. In Victoria, quotas were removed between 1977 and 1986 and replaced with a system in which all dairy farmers are paid a weighted average of market and manufacturing milk prices. Only twelve per cent of Victorian production is used for market milk so the weighted average price is not significantly above the manufacturing milk price. In South Australia, farmers in the metropolitan region receive a share of the premium priced milk sold in the area near Adelaide. Farmers in the south-east receive a payment from the Milk Board in Adelaide as compensation for not having access to the Adelaide milk market. Compensation paid to dairy farmers in the south-east is funded through a levy on market milk sales.

A premium is paid for market milk in each of the States. This premium has varied between States and over time. The greatest margins between market and manufacturing prices have occurred in Tasmania and Queensland while the smallest margins have occurred in Victoria and South Australia. These margins have declined in real terms over time.

Regulation of *interstate* trade in market milk is a more difficult problem for the States because the Australian Constitution enshrines the principle of free trade between the States. In the past, interstate supplies of milk have not been a threat to the market milk premium because the costs of interstate trade have been prohibitive. More recently, the availability of leak-proof plastic bottles and improved road transport has allowed packaged milk to be moved long distances at lower cost. Previously, only heavy glass bottles or cardboard cartons, which leaked on long journeys, were available. Interstate transport of bulk milk has long been feasible, however, state regulations prevent interstate bulk milk from being processed into market milk.

2.2 The manufacturing milk sector

The manufacturing milk sector in Australia can be better viewed as a national industry rather than separate State-based industries. Because a significant proportion of Australia's manufactured dairy produce is exported, federal legislation has been used to implement policies dealing with manufacturing milk. Several policy measures have been used in the manufacturing milk sector.

2.2.1 The equalisation schemes —

Equalisation was introduced in 1934–35 and operated until 1985–86. There was a succession of similar equalisation schemes but minor changes were made from time to time (Griffith 1989). The main aim of equalisation was to pool, or equalise, returns from butter and cheese sold on intrastate, interstate and export markets. Initially its role was to determine Australian butter and cheese prices and to equalise manufacturers' prices for butter and cheese in New South Wales, Victoria, Queensland and Tasmania and cheese in South Australia (Bureau of Agricultural Economics 1974). It operated by voluntary agreements between manufacturers and the controlling committee. There were separate pools for production in each financial year.

Initially, the arrangements were underpinned by both Commonwealth and state legislation. However, the Commonwealth legislation was found to be unconstitutional in 1936. The state legislation continued. Equalisation for casein began in 1946–47 and for skim milk powder in 1970–71.

2.2.2 The Kerin Plan —

Equalisation was replaced by new policies in 1986: the Kerin Plan. Under the Kerin Plan, a tax, called the all milk levy (AML) is imposed on all milk produced in Australia (both market and manufacturing milk). The receipts from this levy are redistributed to exporters of manufactured dairy products as a subsidy on export sales. Export subsidies are set at a fixed rate per tonne of each product so that manufacturers are encouraged to maximise returns from export sales. The Kerin Plan was introduced to yield a somewhat less distorting means of providing assistance than equalisation and has encouraged manufacturers to become more market orientated.

Table 2 shows that there is a net flow of funds from other States into Victoria under the Kerin Plan. This occurs because Victoria is the largest exporter of manufactured dairy products. Dairy farmers in other States also benefit because the export subsidies have increased prices for manufactured dairy products on the domestic market. The overall distribution of benefits and costs will be considered in more detail below using a trade model.

Other forms of assistance to the dairy industry in the Kerin Plan included: underwriting of export prices at 85 per cent of the long-term trend; a cheese tariff quota; and supplementary support for butter and cheese.

Table 3. Levy and subsidy distribution: Kerin Plan (1989–90)

	Vic.	*NSW*	*Qld*	*SA*	*Tas.*	*WA*
			$ million			
Levy	77.02	16.24	11.15	6.82	6.68	4.81
Subsidy	98.79	3.34	3.88	5.59	9.01	0.85
NET	21.77	-12.9	-7.27	-1.23	2.33	-3.96

2.2.3 New manufacturing milk arrangements —

Following the Industry Commission (1991) inquiry into the dairy industry in 1991, new arrangements were introduced for manufacturing milk. These arrangements allow for a continuation of the main elements of the Kerin Plan except that export subsidies are to be phased down to a market support rate of 10 per cent by 1999. The market support rate in 1991–92 was 22 per cent. The new arrangements dispense with the underwriting provisions but retain the cheese tariff quota arrangements. The amended legislation also abolished the *comfort clause* of the Kerin Plan. The comfort clause allowed the State Governments to suspend the all milk levy. Its main purpose was to allow New South Wales to suspend the scheme should Victoria not restrict the amount of market milk it exported to New South Wales.

The following sections examine the efficiency costs of the current set of policies using the spatial equilibrium model of the dairy industry. The impact of the new arrangements is also examined in terms of the likely impact on the size and structure of the dairy industry.

3. The Dairy Policy Model

To understand and quantify some of the main effects of dairy industry regulation, a policy model of the Australian dairy industry has been developed over the last several years in the Victorian Department of Agriculture. The structure of this model is summarised in an appendix to this paper and it is fully documented in Daniel and Bardsley (1993).

The Dairy Policy Model is a spatial equilibrium model describing production, trade and consumption of milk between several centres. There are six production regions (one for each State), and eight demand centres consisting of domestic consumption in each of the six States, demand for milk as an input into the manufacturing sector, and export demand. Manufacturing is treated as a non-localised sector, close to all regions. Supply and demand centres are described by a supply or demand function. In principle the functional form is arbitrary, but in practice a constant elasticity log-linear functional form has been used. The model solves market clearing conditions to determine endogenously quantities produced and consumed, producer and consumer prices, whether trade occurs between nodes, and the direction and magnitude of this trade. Producer and consumer surplus measures are then calculated as welfare indicators.

Exogenous inputs are world dairy demand, and State and Commonwealth policy

interventions into the market. These policy interventions are of two forms. Tax and subsidy instruments are used to tax milk production and to subsidise exports, and similar instruments are notionally used in price pooling States to drive a wedge between producer and consumer prices. Given the policy intervention (for example the regulated price differential between producer and consumer), the tax/subsidy arrangement is determined endogenously within the model from the required price wedge and the budget constraint that tax revenue be exactly sufficient to fund the subsidy. The second type of intervention is the use of quotas on production or on trade between points. These constraints are introduced into the model as Kuhn-Tucker equations that must be solved simultaneously with the market clearing conditions and the tax/subsidy budget identities. A useful side product of this approach is that Lagrange multipliers are calculated for all binding trade or production constraints. These Lagrange multipliers are an indication of the incentive for individuals to evade these constraints; they are thus an indication of the feasibility of regulations.

Irrespective of the functional form of the supply and demand equations, once the policy interventions are introduced the model is highly non-linear and it must be solved numerically. As parameters are varied, constraints switch in and out changing the pattern of trade and production. Wilcox and Bardsley (1990), for example, varied the world price to derive an export supply curve and described the varying regulatory regimes that were traced out. The model also lends itself to exploring policy options.

There are a range of regulatory interventions that are not included in the model, for example regulations on the transport of milk within States and the regulation of various manufacturing and marketing margins. To the extent that these regulations are omitted, it is likely that this model will underestimate the costs of regulation. The model also omits important technical features of the milk market, chief of these being the strong seasonality in milk production. The exact importance of this omission is a topic for future research, but low levels of trade between centres may conceal larger but offsetting seasonal flows. Once again, the costs of regulation may be under-estimated.

4. Efficiency Costs of Dairy Policies

In this section, the Dairy Policy Model is used to estimate the efficiency costs and transfers associated with the various policy measures that exist in the dairy industry. This has been achieved by comparing results of the model with and without the assistance policies in place.

We have estimated the effect of removing all assistance to the dairy industry on consumers' and producers' surplus. The results of this analysis can be found in table 3 where it can be seen that the market milk policies in all States increase producers' surplus by $385.5 million per year (assuming a supply elasticity of 1.0). The largest transfers occur in those states (NSW, Queensland) where a significant proportion of total milk production is used for market milk rather than manufacturing milk purposes. In the Manufacturing milk states of Victoria, South Australia and Tasmania, the transfers associated with the market milk premium are smaller particularly when these are considered relative to the total volume of milk produced. The table also shows that assistance measures for the manufacturing milk sector increase producers' surplus by $146.1 million per year. The efficiency cost, or dead weight loss resulting from both market and manufacturing milk assistance measures in Australia has been estimated at $59.5 million per year. Table 3 also contains estimates of the above measures using

supply elasticities of 0.5 and 1.5.

Table 4 Economic surplus changes when both market milk support and the Kerin Plan are removed

	Supply elasticity		
	0.5	*1.0*	*1.5*
	$m	$m	$m
Change in consumers' surplus			
Market milk			
Vic.	83.5	81.9	78.3
NSW	139.1	137.1	132.2
Qld	96.0	94.9	92.3
SA	27.1	26.7	25.4
Tas.	10.5	10.3	9.9
WA	35.4	34.9	33.7
Total market milk	391.6	385.8	371.8
Manufactured dairy products	155.0	146.1	126.0
TOTAL	546.6	531.9	497.8
Change in producers' surplus			
Vic	-193.0	-169.7	-137.6
NSW	-134.4	-129.7	-123.2
Qld	-98.5	-95.1	-90.4
SA	-30.0	-26.2	-21.9
Tas.	-19.9	-17.4	-14.3
WA	-35.8	-34.3	-32.3
TOTAL	-511.6	-472.4	-419.7
EFFICIENCY COST	35.0	59.5	78.1

Source: estimated from the results of our model simulations

These estimates are of a similar magnitude to those presented by Freebairn (1992). Using a supply elasticity of 0.5 and export parity prices, Freebairn estimated a transfer from consumers to producers because of market milk policies to be $337 million compared with our estimate of $392 million. For a supply elasticity of 1.5 and a competitive outcome without exports, Freebairn estimated a transfer of $311 million compared with $372 million from our model. It is likely, however, that the impact in terms of transfers to

producers of the market milk quota schemes in NSW, Queensland and Western Australia, will be greater than indicated by our analysis. This is because quota schemes cause more milk to be produced than would be the case in an unregulated market due to the insurance milk phenomenon. The inefficiencies of non-transferable market milk quota schemes, in relation to insurance milk, have been explained by Parish and Kerdpibule (1968), Alston and Quilkey (1980) and Daniel and Bardsley (1993).

Freebairn (1992) also estimated the costs and transfers of manufacturing milk policies in Australia for 1989-90. He found that the transfer from consumers to producers because of the Kerin Plan was $180 million using a supply elasticity of 0.5 and $140 million using a supply elasticity of 1.5. Thus, Freebairn estimated total transfers for manufacturing and market milk policies together of $517 million and $451 million. He estimated total efficiency costs of market milk and manufactured milk at $33 million and $72 million for supply elasticities of 0.5 and 1.5, respectively. By comparison our own estimates of efficiency costs in table 3 are $35 million and $78 million.

Using a supply elasticity of 1.5, Freebairn found that Australia no longer exported dairy products when all market milk and manufacturing milk support was removed. In our own simulations, exports fall to zero at a supply elasticity of 1.5 with all support removed. Freebairn uses a non-traded price above the export price as a benchmark to determine his estimate. Our model does not include import competition and we have not imposed any exogenous proxies for an import parity price. Studies of the supply of milk in Australia suggest that the realistic supply elasticity values are somewhere between 0.5 and 1.0. Therefore, Australia is likely to remain an exporter of dairy products when all assistance measures are removed and the elasticity of supply lies between 0.5 and 1.0.

5. Deregulation of the Dairy Industry

The estimates presented above, apply to the policy settings in the dairy industry in 1989-90. Since then, there have been significant revisions to the level and scope of assistance available to the dairy industry. In this section, the Dairy Policy Model is used to examine the impact of the most recent changes to dairy policies on exports, milk production and consumption and farm gate prices. The Model is also used to explore the consequences of deregulation on interstate rivalry and to identify the incentives to break out of the regulatory framework.

5.1 Changing Government Policies

In line with the general movement to deregulate the Australian economy, the Industry Commission inquiry into the dairy industry recommended a phased reduction of assistance. The eventual outcome was a plan to phase down assistance by reducing the subsidy on exports of dairy products. This is to be achieved by reducing the market support rate from its current rate of around 17 per cent to 10 per cent by 1999. While the Industry Commission made recommendations about market milk, the Commonwealth does not have powers to influence the level of assistance for market milk, which is controlled by state legislation. The Dairy Policy Model has been used to examine the impact of these changes in government policy. Figures 1, 2, 3, and 4 illustrate the impact of reducing the market support rate from 17 to 10 per cent while holding the state market milk arrangements in place.

This analysis shows that the greatest impact of the decline in assistance for manufacturing

milk will be to reduce the volume of exports from Australia by 20 per cent, see figure 1. Exports from Victoria, the largest exporter of dairy products and the recipient of most of the export subsidies, are estimated to decline by 25 per cent. In other States, reducing export subsidies will have less impact because most milk produced is used for market milk rather than manufacturing milk. Total production of milk (figure 2) is expected to decline by only 6 per cent in Australia but most of this reduction is likely to occur in Victoria. The model results depicted in figure 3 indicate that there will be a small increase (1.5 per cent) in the amount of domestic manufacturing milk consumed in Australia. This will occur because the reduction in export subsidies will lower the price of manufacturing milk in Australia resulting in an increase in consumption. Figure 3 shows that Victoria, and to a lesser extent South Australia, would pick up a larger share of the domestic manufacturing milk market as NSW, Queensland and Western Australia scale down production. Under complete deregulation the quota States cease exports and their production of manufacturing milk falls substantially. This is an important finding because it may mean that, in the longer term, part of the domestic manufacturing capacity could be drawn to Victoria as the patterns of milk production change. Currently, manufacturing establishments in Victoria supply 60 per cent of domestic market requirements. Figure 4 illustrates the impact of these changes on the farm-gate price of milk.

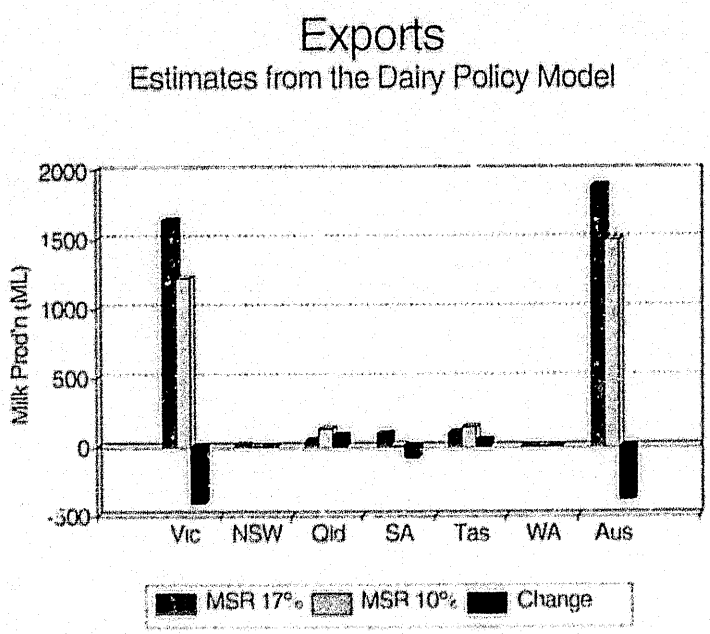

Figure 1

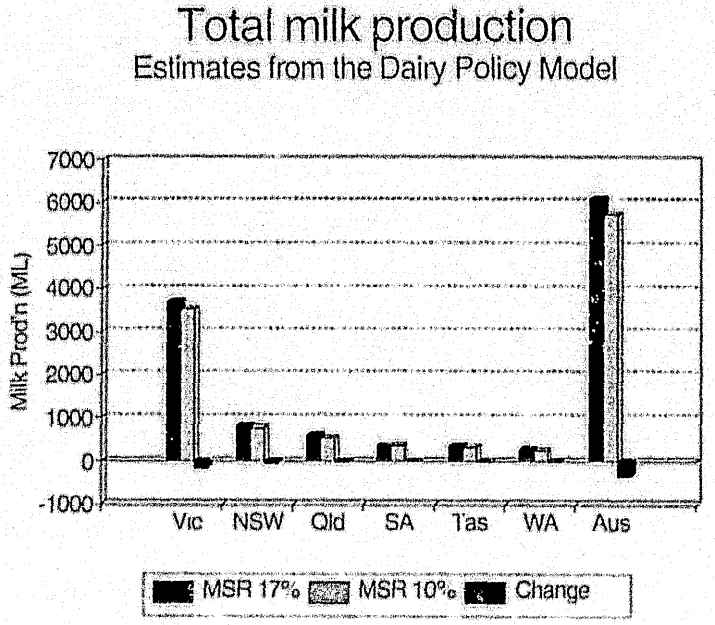

Figure 2

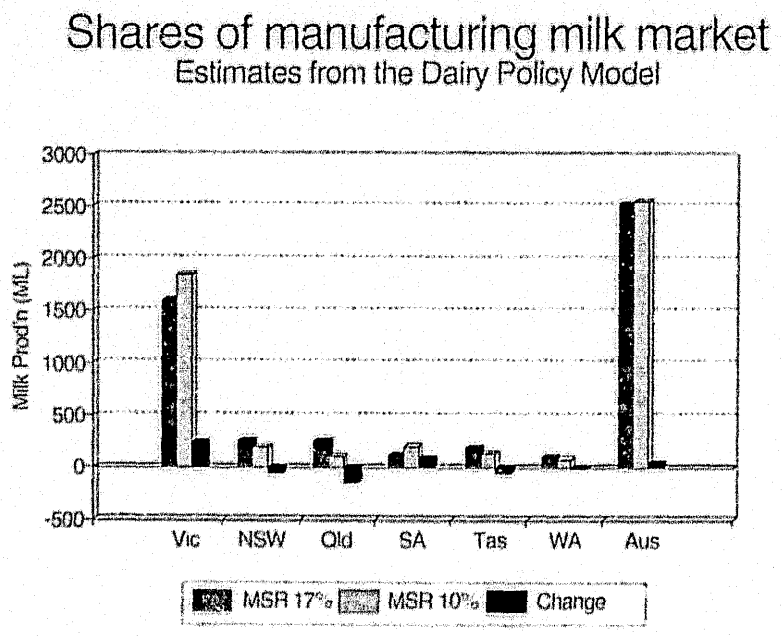

Figure 3

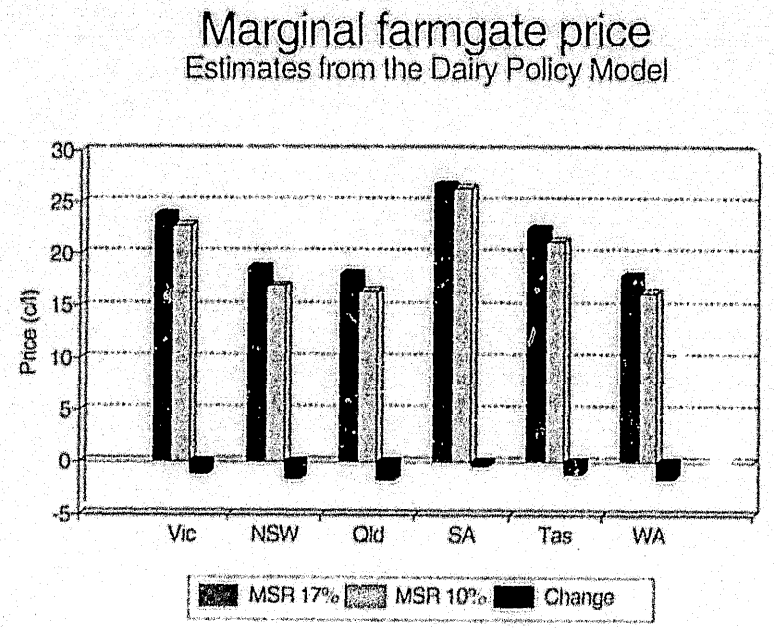

Figure 4

5.2 Competition in the dairy market

Regulations in the dairy industry have meant that dairy farmers and dairy manufacturers receive significant transfers from consumers. This occurs because regulations have sanctioned higher prices for dairy products than would occur in a deregulated industry. Commonwealth legislation has raised the price of domestic and exported manufactured dairy products, and state legislation limits competition on the price of market milk. In a competitive market, it is usual for the rents (the return to resources in excess of marginal cost) to be dissipated by competition. Besides providing mechanisms that raise the prices of dairy products, dairy regulations are also intended to ensure that rents are distributed equitably between dairy farmers. The averaging of manufacturing and market milk prices in Victoria; the tax/subsidy arrangements of the Kerin Plan; and the compensation payments to farmers in the south-east of South Australia are all mechanisms that attempt to distribute rents between dairy farmers. Without these or other methods of rent distribution, large differences in farm incomes would develop and disadvantaged groups of farmers would challenge the existing regulations.

Figure 5 illustrates the distribution of rents by State, indicating that Victoria receives the largest total share at $169 million with NSW the next largest recipient with $130 million per year. Figure 5 indicates that most of the rents (24 per cent) to Victorian dairy farmers are derived from the manufacturing milk arrangements while the reverse is true for those States which mostly produce market milk. NSW receives nearly 77 percent of these rents from market milk arrangements, Queensland receives 78 per cent, and Western Australia 75 per cent. To a large extent, the Kerin Plan, which taxes all milk produced and subsidises exports of manufactured milk, is a mechanism that more equitably distributes the rents from farms that produce mostly market milk to those that produce mostly manufacturing milk. It can be regarded as a method of compensating farmers in the

manufacturing States for the restrictions on access to the market milk premium available in other States. Victoria, Tasmania and parts of South Australia, which produce much of the manufacturing milk in Australia, are net gainers from the tax/subsidy arrangements of the Kerin Plan. This point is illustrated in table 2.

Figure 6 depicts the distribution of rents on a per farm basis in each of the States. It shows that the largest average rents of around $70,000 per farm are captured by Western Australian farmers followed by NSW and Queensland farmers where the average per farm is around $55,000 and $45,000, respectively. The States that are more heavily orientated to manufacturing milk receive rents of around $20,000 per farm.

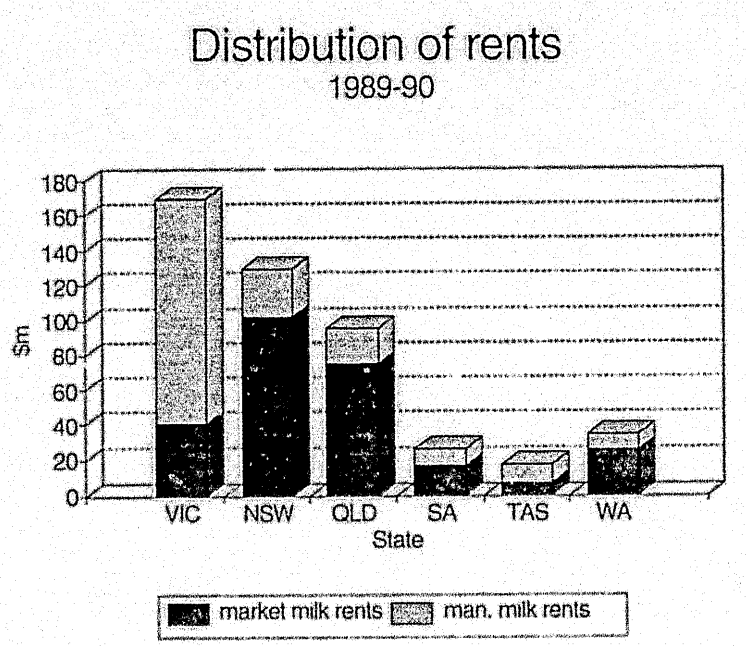

Figure 5

The changes in manufacturing milk policy embodied in the most recent change in Commonwealth dairy legislation will effectively reduce the rents to producers of manufacturing milk and significantly disrupt the distribution of rents between dairy farmers. This will become evident on a state basis, particularly in Victoria where nearly 90 per cent of milk produced is used for manufacturing purposes and within States where there is uneven access to the market milk premium. As manufacturing assistance is reduced, Victorian farm incomes will decline relative to incomes in States where production is mostly used for market milk, and pressures will emerge to even up interstate discrepancies in income. When it is also considered that new industry arrangements (explained in section 2.2.3) have removed underwriting provisions, which previously limited the extent to which prices could fall from one year to the next, the pressure for a revision of existing market milk arrangements will become acute when the price of milk products on the export market weakens. Pressure for change will become evident as an increasing difference in the farm-gate price for market milk compared with manufacturing milk. This difference in price will create incentives for greater interstate trade as this enables manufacturing milk States to utilise a greater proportion of total

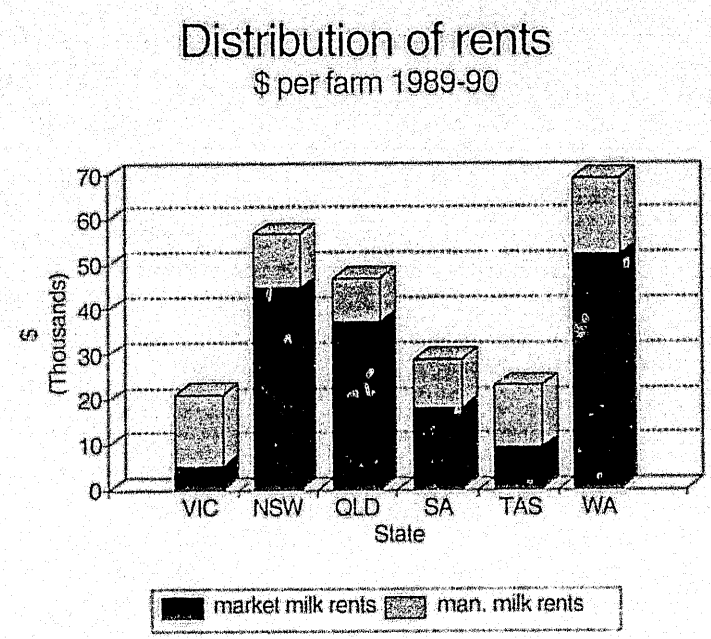

Figure 6

production as market milk. It may also strain the market milk arrangements in those States that do not evenly distribute the rents derived from the market milk premium (the quota States).

The Dairy Policy Model provides some indication of the pressures on the market milk arrangements under the current path of deregulation in the dairy industry. Table 4 shows that under the current arrangements it would be profitable for trade to occur from: NSW to Victoria (1.2 c/l profit); NSW to Qld (17.2 c/l); NSW to South Australia (10.6 c/l). The incentives for trade are observed as shadow prices from the model and represent the profit that could be earned by trading additional litres of milk interstate. Table 4 also shows that it would be profitable to trade from Qld to NSW (11.9 c/l) as well as in the reverse direction from Qld to South Australia (23.3 c/l). This is because of the profits to be made if milk destined for manufacturing purposes could be sold as market milk. The middle panel of table 4 shows that shadow prices tend to increase when the subsidies on manufactured dairy products are reduced. This occurs because the market milk premium (the margin between market and manufacturing milk prices) increases as the support for, and therefore the price of, manufacturing milk declines. The final panel in table 4 indicates that shadow prices fall to zero or negative when the regulations supporting market and manufacturing milk prices are removed. This suggests that in a deregulated milk industry, transport costs largely overshadow any comparative advantage in milk production that exists in different regions. These results indicate that it is the market milk premium that creates incentives for trade between States and that perverse trade patterns may emerge if the rate at which assistance for manufactured milk is removed is different to the rate of deregulation in the market milk sector. It should be remembered, however, that the model is based on annual data and the inclusion of seasonality may alter this conclusion.

Table 4 Incentives to evade supply quotas or restrictions on interstate trade in market milk (supply elasticity = 1.0)

Base Run

Source	*Vic.*	*NSW*	*Qld*	*SA*	*Tas.*	*WA*
Destination	¢/L	¢/L	¢/L	¢/L	¢/L	¢/L
Vic.	0	1.2	-0.3	-2.8	-10.6	-10.3
NSW	-3.7	17.2	11.9	-1.0	-15.0	-9.8
Qld	-7.6	10.6	23.3	-14.5	-19.1	-18.9
SA	-8.8	-3.8	-4.6	0	-21.4	-4.3
Tas.	-15.7	-14.9	-14.2	-17.1	0	-31.4
WA	-31.8	-36.9	-41.8	-11.6	-45.1	17.1

Kerin Plan Reduced to 5%, No Change to Market Milk

Source	*Vic.*	*NSW*	*Qld*	*SA*	*Tas.*	*WA*
Destination	¢/L	¢/L	¢/L	¢/L	¢/L	¢/L
Vic.	0	5.6	4.2	-0.3	-7.1	-5.7
NSW	-3.7	21.6	16.3	1.5	-11.4	-5.4
Qld	-7.6	15.1	27.8	-12.0	-15.5	-14.4
SA	-8.8	0.7	-0.1	0	-17.9	0.2
Tas.	-15.7	-10.5	9.8	-14.6	0	-27.0
WA	-31.8	-32.5	-37.3	-9.1	-41.6	21.5

Manufactured milk and market milk support removed

Source	*Vic.*	*NSW*	*Qld*	*SA*	*Tas*	*WA*
Destination	¢/L	¢/L	¢/L	¢/L	¢/L	¢/L
Vic.	0	-10.9	-12.3	-9.6	-20.5	-22.2
NSW	-8.9	0	-5.3	-12.9	-30.0	-27.0
Qld	-18.9	-12.7	0	-32.6	-40.2	-42.2
SA	-10.2	-17.1	-17.9	0	-32.6	-17.6
Tas.	-19.2	-30.5	-29.8	-27.4	0	-47.0
WA	-36.8	-54.0	-58.5	-23.4	-60.0	0

There are, however, significant barriers to any redistribution of rents through interstate trade. Each of the States limits intrastate competition from manufacturing milk through the various supply control or price pooling arrangements. Other legislation, such as Section 50 of the Victorian *Dairy Industry Act 1992* (previously Section 38(1) of the Victorian *Dairy Industry Act 1984*) also prevents interstate competition between manufacturing and market milk. This legislation allows the Victorian Dairy Industry Authority (VDIA) to set the price at which market milk is sold interstate. In practice, it requires processors to pay *market milk* rather than *manufacturing milk* prices for milk sold interstate as market milk. Section 50 does not physically restrict interstate trade but limits the extent to which manufacturing milk can be diverted into market milk uses, thereby preventing competition on the market milk premium. These arrangements effectively limit the extent to which the rents associated with the market milk premium can be redistributed through interstate trade in market milk. How long these arrangements will hold in the face of an increasing divergence between market and manufacturing milk prices depends to a large extent on the nature of alternative arrangements that could be put in place.

As support for manufacturing milk declines relative to market milk, the above analysis indicates that there will be an increasingly inequitable distribution of rents across States and between farms. It is unlikely, however, that the free market will be allowed to allocate resources in the dairy industry because the market milk premium would be a casualty of this approach. Dairy farmers will avoid this option, where possible, because all dairy farmers could be financially worse off if the market milk premium were removed. A more likely outcome is some voluntary sharing of market milk supply between Victoria and other States negotiated through the political process. This solution may address the perceived equity problem created by partial deregulation but does not necessarily mean that economic efficiency in the dairy industry will improve.

5.3 The impact of changing technology on the dairy industry

Another important impetus for change in the dairy industry is the speed and direction of technical change. As indicated earlier in the paper, technical change has been one of the most significant forces shaping the dairy industry. In terms of its impact on the structure of the dairy industry, the most important source of technical change may occur in the product technology area rather than in production technology.

When new products emerge, they are not always included in current pricing arrangements. Long-life milk using ultra heat treatment (UHT) technology is an example of the problems that inconsistent treatment of new products in highly regulated markets can cause. Inconsistent pricing of flavoured milk between States has also caused concern for dairy farmers.

New technology often presents new production, stockholding and transportation possibilities for the industry. UHT for example, may provide an alternative method of supplying off-season milk. It may also lower the cost of transport to certain destinations and could create new possibilities for milk sales. It could also open the possibility of New Zealand exporting liquid milk to some parts of Australia. Other combinations of skim milk and non-dairy fats could also exclude milk-like products from current legislative definitions of market milk.

The dilemma facing the various dairy authorities is what level of control of these products

is feasible. For example, if UHT milk is priced in the same way as market milk, this may give New Zealand a very profitable trade opportunity. If UHT is priced as manufacturing milk, it could drastically under-cut the price of market milk and win significant market share.

Another technology, reverse osmosis, whereby milk can be concentrated for transport and then reconstituted close to the point of consumption, may also place pressure on market milk pricing in the future. Whichever technologies prevail, continuing pressure on dairy regulation is likely.

6. Conclusions

The dairy industry remains one of the most regulated agricultural industries in Australia. Prices and distribution are controlled by a labyrinth of state and Commonwealth regulations. The first regulations were primarily concerned with protecting public health but by the 1920s and 1930s, governments began introducing controls over pricing and distribution. Like many agricultural industries, the dairy industry in Australia has attempted to address questions of supply, pricing and distribution with political rather than economic solutions. This suited the industry well for many decades but economic pressures in recent years have diminished the industry's hard won privileges. Trade pressure from New Zealand and a general drive for reduced industry assistance has led the Commonwealth Government to reduce assistance to manufactured dairy produce. Improved production, packaging, transport and processing technologies have made the distinction between market milk and manufacturing milk obsolete and the isolation of individual state markets for fresh milk tenuous. Nevertheless, the complex web remains.

The maze of regulations, pricing and other arrangements in the dairy industry cause significant resource allocation costs in the economy. In this paper, we have estimated the transfers from consumers of milk and dairy products to producers at between $419 million and $511 million. The cost of the market and manufacturing milk regulations, in terms of reduced efficiency in the economy, has been estimated at between $35 million and $78 million. However, the real efficiency cost resulting from the market milk regulations, is likely to be higher than the estimate presented in this paper because it has not been possible to model adequately the restrictions on quota transfer that exist in NSW and Queensland and the insurance milk phenomenon.

Using the dairy policy model outlined in this paper, it has been estimated that the recent changes to government policies influencing the manufacturing milk sector will reduce exports from Australia by 20 per cent; reduce total milk production by 6 per cent; reduce the farm-gate price of milk in all States; and increase the consumption of manufactured milk products by 1.5 per cent. One key finding to emerge from this analysis is that unless market milk assistance is reduced at a similar rate to that occurring for manufactured milk, there will be pressure for perverse patterns of trade in market milk resulting in unnecessary investment in market milk trade. The incentive for interstate trade, indicated by shadow prices, becomes stronger as assistance for manufacturing milk is removed. This occurs because interstate trade is one way of exploiting the increasing price differential between market and manufacturing milk. The incentive for trade falls, however, when both manufactured and market milk assistance is removed.

As assistance for manufacturing milk is removed, the discrepancy between the prices of market and manufactured milk will become evident in the incomes of dairy farmers in

different States. In the predominantly manufacturing States of Victoria, South Australia and Tasmania, rents derived from price setting arrangements are anticipated to fall to less than half that of the market milk States of NSW, Queensland and Western Australia.

There are several possible consequences of this discrepancy in the distribution of rents between States, including the breakdown of market milk regulations. This is unlikely, however, as dairy farmers in all States would lose the market milk premium. A more likely outcome is some form of negotiated access for market milk, particularly between Victoria and NSW, aimed at retaining the market milk premium and providing a more equitable distribution of rents between the States. If this solution eventuates, there will be economic efficiency costs associated with the perverse patterns of trade predicted by the Dairy Policy Model. A more sensible approach would be for the dairy industry to reduce the market milk premium in parallel with the reduction in manufacturing assistance and to rely on commercial rather than political criteria to determine the patterns of trade and investment in the dairy industry.

Appendix The Dairy Policy Model: equations

The price equilibrating problem

The model is a spatial equilibrium model. Therefore, its primary purpose is to simulate the flow of milk from suppliers to consumers under various conditions. A system of simultaneous equations represents trade in milk and dairy products. These equations permit the effects of policies to be simulated and allow for trade in fresh milk between States. Market clearing conditions link equations defining the demand and supply functions for each State. The model solves the market clearing conditions so that the demand price equals the supply price, given transport costs, marketing margins and policy constraints.

Transport costs, marketing margins and variables to describe policies are exogenous and can be varied by the user. Policy instruments are specified as taxes, subsidies or constraints on production or supply. The model is specified in a general way to allow for flexibility in the policy options considered.

The model includes n producing regions and m markets for this milk. With n producing regions and m consuming markets, there are $m \times n$ flows of milk, Q_{ij}, from each region, i, to each market, j. To estimate the quantities of milk, Q_{ij}, flowing from each supply region to each demand region, $m \times n$ simultaneous equations are needed. These simultaneous equations equate farm gate supply prices and retail prices, subject to transport costs, marketing margins and government policies. There are $m \times n$ transport costs, tr_{ij}, from each supplier, i, to each market, j. With no government intervention the $m \times n$ simultaneous equations are

$$P_{Dj} = P_{Si} + tr_{ij} \qquad (1)$$

Supply and demand functions

Linking the quantity variables, Q_{ij}, which are unknown, to the price equilibrating condition, equation (1), are n supply curves and m demand curves. In principle, there are no restrictions on the functional forms that can be used for the supply or demand functions. However, in the version of the model tried here, constant elasticity log-linear supply and demand curves have been used. These supply and demand curves require only elasticities and prices and quantities produced or consumed in a particular base period.

The farm gate supply price for milk can be expressed as

$$P_{Si} = \bar{P}_{Si} (Q_{Si} / \bar{Q}_{Si})^{1/\varepsilon_i} \qquad 1 \le i \le n \qquad (2)$$

where P_{Si} is the farm gate price in region i, $\bar{P}_{Si}$ is the actual farm gate supply price in the base period in region i, $\bar{Q}_{Si}$ is the actual quantity produced by region i in the base period, ε_i is the price elasticity of supply for region i and

$$Q_{Si} = \sum_{j=1}^{m} Q_{ij} \qquad 1 \le j \le m \qquad (3)$$

where Q_{ij} is the quantity of milk flowing between supplying region i and market j. This supply function is a power function passing through the point, ($\bar{Q}_{s}$, $\bar{P}_{s}$) and through the origin. The elasticity of supply is constant.

The demand price for milk can be expressed as

$$P_{dj} = \bar{P}_{dj} (Q_{dj} / \bar{Q}_{dj})^{1/\eta_j} \quad (4)$$

where P_{dj} is the demand price for milk in market j, $\bar{P}_{dj}$ is the actual demand price in market j in the base period, $\bar{Q}_{dj}$ is the quantity consumed in market j in the base period, η_j is the price elasticity of demand in market j and

$$Q_{dj} = \sum_{i=1}^{s} Q_{ij} \quad (5)$$

The demand function is a rectangular hyperbola (because η is negative) passing through the point ($\bar{Q}_{d}$, $\bar{P}_{d}$). The elasticity of demand is constant.

The solution procedure of the model (described later) continues to substitute different values for each Q_{ij} until equation (1) is satisfied.

Modelling government dairy policies

Price averaging for milk sold in different markets

The averaging of prices received for milk sold to different markets (also called price pooling, blend pricing and equalisation) is treated in the model as a tax–subsidy arrangement. Pooling of returns from market milk and manufacturing milk occurs in Victoria, South Australia and Tasmania. However, a similar method could be used to represent equalisation of returns from manufactured dairy products sold on the domestic and export markets such as occurred from 1934 to 1986.

Figure 7 shows the effect of averaging the returns from market milk and manufacturing milk. If the government holds the price of market milk above the price of manufacturing milk and total production is greater than market milk consumption, Q_m, the farmers' marginal price for milk is a weighted average of the fresh milk price, P_m, and the manufacturing milk price. As this price is higher than the manufacturing price but lower than the market milk price it can be modelled as a tax on market milk production and a subsidy on manufacturing milk production. The averaging occurs because each dairy farmer in the State receives a proportional share of the returns from market milk.

The model determines the taxes and subsidies endogenously. Two conditions are required for this. The price wedge created by the tax and subsidy must induce the regulated price premium, and the notional tax revenue must exactly fund the notional subsidy. The number of taxes, tax_m, and subsidies, sub_m, depends upon how many supply regions practice price averaging, which demand prices are averaged and how they are averaged. For example, under current Victorian legislation, all milk used for market milk receives the same price despite its of destination. Therefore, there is only one tax, tax_{vm}. In addition, all milk used for manufactured dairy products receives a market-determined price, so there is only one subsidy, sub_{vm}. The market clearing equation (1) changes so that

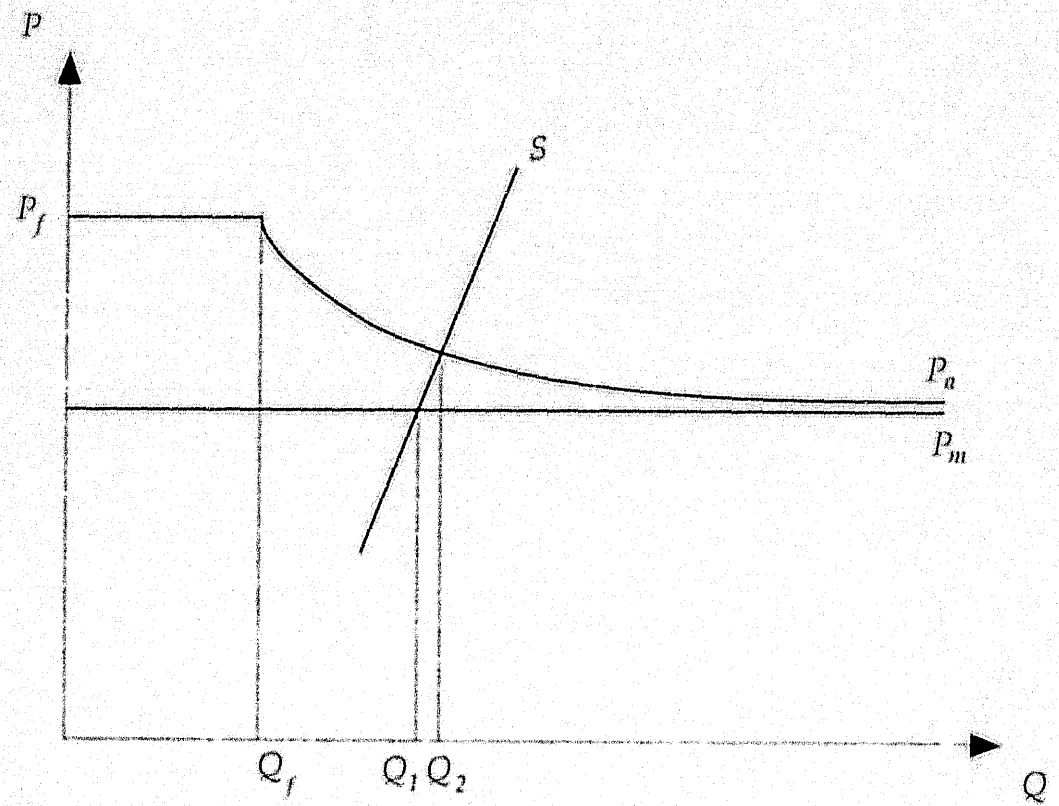

Figure 7 Averaging fresh milk and manufacturing milk prices

(6) $$P_{p} = P_{s} + tr_{a} + Tx_{a}$$

where

(7) $$Tx_{a} = (tax_{s} \times poltax_{a}) + (sub_{s} \times polsub_{a})$$

The variables, $poltax_{a}$ and $polsub_{a}$ are ones where the tax or subsidy exists and zeros where it does not. Therefore, there is an $m \times n$ matrix of taxes and subsidies, Tx_{a}. With two additional endogenous variables, two additional simultaneous equations are necessary to complete the system. First, where price averaging occurs, the market milk demand price is held fixed above the manufacturing milk price. For example, section 50 of the *Dairy Industry Act 1992* (section 38(1) of the *Dairy Industry Act 1984*) means that market milk produced in Victoria and consumed in Victoria is sold at a fixed price. The other condition is that because there is no actual tax or subsidy or flow of money, the total tax collected in each State must equal the total subsidy paid out in each State. Thus,

(8) $$P_{p} = F_{p}$$

where F_{p} is the exogenous fixed price for market milk. This equation must be true in all States where farmers receive an equalised price for all their milk. The following budget condition must also apply as there is no net subsidy or tax on the industry.

(9) $$0=\sum_{j=1}^{m} Tx_{ij} \times Q_{ij}$$

This means that the total tax collected equals the total subsidy provided in each State.

Market support payments and the all milk levy (the Kerin Plan)

Under the Kerin Plan, market support payments are subsidies paid on exports funded from a levy on all milk produced. The model determines endogenously the market support rate subject to the condition that the total subsidies paid out must be equal to the levies collected. Therefore, equation (6) becomes

(10) $$\hat{P}_{ij} = P_{is} + tr_{ij} + Tx_{ij} + A_i$$

where A_i is the all milk levy for each producing region in cents per litre of raw milk. This is obtained by multiplying an exogenously set all milk levy, in cents per kilogram of butterfat, by the average butterfat content of milk in each producing region, and

(11) $$\hat{P}_{ij} = P_{ij}, \text{ except that } \hat{P}_{ij_{export}} = P_{ij_{export}}(1+m)$$

In equation (11), m is the market support rate determined endogenously according to the condition that

(12) $$\sum_{i=1}^{n} (A_i \times Q_i) = m \times P_{ij_{export}} \times Q_{ij_{export}} + admin$$

where *admin* is the cost of administering the scheme. This means that the total revenue collected by the Government with the market support levy must equal the total subsidy paid out on export subsidies.

Other tax and subsidy arrangements, such as the butter and cheese domestic tax and export subsidy that was progressively removed under the Kerin Plan, could be modelled in a similar way.

Quotas and restrictions on endogenous variables

At present, Australian State Governments use one of two methods of increasing the prices which farmers receive for market milk. Victoria, South Australia and Tasmania use a price averaging or pooling system that we have already described. New South Wales, Queensland and Western Australia use quota restrictions on the supply of milk for fresh consumption to maintain high prices. These quotas allow farmers access to the high priced fresh milk market in their own State[2].

Besides explicit quotas, there are implicit (and effective) restrictions on interstate trade in market milk that can be represented as a zero quota on interstate market milk trade.

All endogenous variables in the model, Q_{ij}, tax_{ij}, sub_{ij} and m, pass to the equation solving program in a form that puts an upper and lower bound on each one. If no restriction is necessary, the bounds are set well above and below the expected result. That is

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[2]The New South Wales quota policy does provide for farmers in other States to purchase quotas but only after the other States' Governments have certain legislative and regulatory requirements in place (New South Wales Dairy Corporation 1990).

(13) $$LQ_n < Q_n < UQ_n$$

(14) $$Ltax_t < tax_t < Utax_t$$

(15) $$Lsub_t < sub_t < Usub_t$$

(16) $$Lm < m < Um$$

where LQ_n, $Ltax_t$, $Lsub_t$, Lm, UQ_n, $Utax_t$, $Usub_t$ and Um are the respective lower and upper bounds. The restrictions are imposed by passing not the endogenous variables themselves to the solution algorithm but an inverse logistic transform of the endogenous variables. This takes the form

(17) $$x_n = \ln[(g_n - l_n)/(u_n - g_n)]$$

where x_n are the transformed endogenous variables constrained above and below by the upper and lower bounds, u_n and l_n. The g_n are the unconstrained endogenous variables. Figure 8 is a graph of this function.

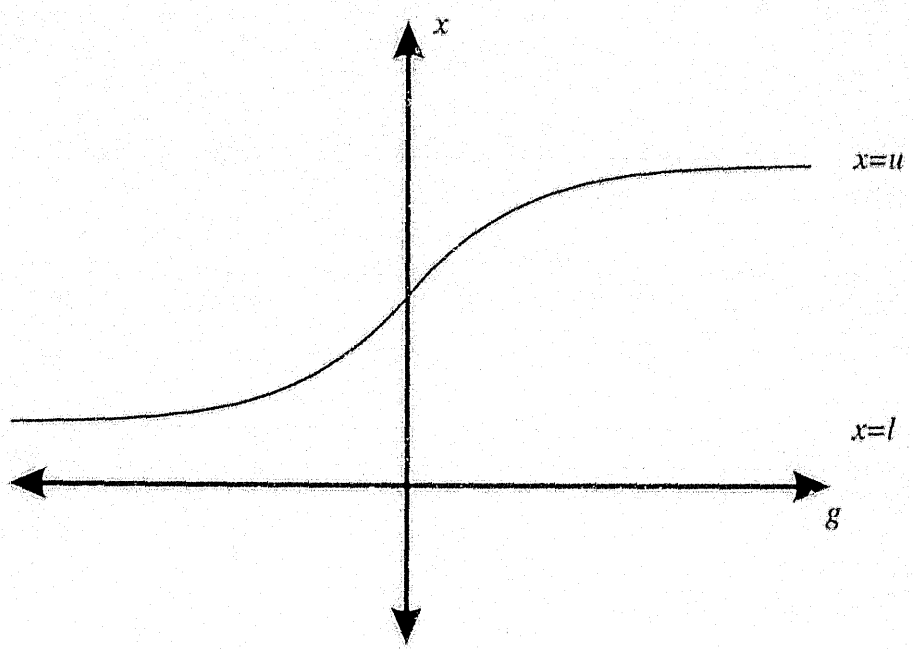

Figure 8 Inverse logistic transform

After passing through the Gauss NLSYS solution algorithm, the new values of the endogenous variables are transformed back to their original form by the logistic transform

(18) $$g_{ij} = l_{ij} + (u_{ij} - l_{ij})/(1 + e^{-b_{ij}})$$

Representing quotas in the ways described above is accurate if they are freely tradeable both spatially and temporally. In such a system the earning capacity of the quota would be reflected in its traded price. They would have no effect on the quantity of milk supplied as the marginal price for milk would still be the manufacturing milk price.

Solution procedure

If equations (8), (9), (10) and (12) are rearranged with all the variables on the right hand side we get:

(19) $$0 = P_D - tr_{ij} - Tx_{ij} - A_i - P_S$$

(20) $$0 = P_D - F_D \text{, where blend pricing exists}$$

(9) $$0 = \sum_{j=1}^{m} Tx_{ij} \times Q_{ij}$$

(21) $$0 = \sum_{i=1}^{n} (A_i \times Q_S) - m \times P_{D_{export}} \times Q_{D_{export}}$$

The number of equations is equal to the number of unknown endogenous variables (Q_{ij}, tax_{ij}, sub_i and m). The equations are solved using the NLSYS algorithm that comes with the GAUSS programming language. GAUSS is a matrix-oriented language for mathematical applications. The NLSYS program uses a quasi-Newton method to find the zeros of a system of non-linear equations (Aptech Systems, 1990). Using an iterative procedure, NLSYS substitutes various values into the endogenous variables until each of the above equations is within a specified tolerance of zero.

To feed the structure of our model of the dairy industry into the NLSYS routines of GAUSS we have written a program that translates the $m \times n$ matrices of variables into the form required by NLSYS and translates the answers back into the original form. This allows any of the endogenous variables and their concomitant equations to be dropped from the model so that the presence or absence of particular policies can be easily simulated. It also means that insignificant variables can be dropped to make the model quicker and easier for NLSYS to solve.

The supply and demand elasticities used in the model are based on previously published studies. Many estimates of demand elasticities for milk and dairy products have been made and several estimates of supply elasticities are available. There is variation between the estimates made by different authors and we have tested the sensitivity of the results to a range of elasticities. Our supply elasticities have been based primarily on those of Lembit and Hall (1987) and Barbeler and Hamilton (1974). Demand elasticities are an amalgam of estimates from some 15 previous studies.

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