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## Industry Versus On-Farm Rates of Change: Australian Dairy Farming During the 1970's

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The Australian dairy industry has been under severe economic pressure in the past decade. In adjusting to this, the industry has undergone a substantial decline in the number of farms and in production. As in other declining industries, the time path of average farm characteristics reflects not only changes made to continuing farms (on-farm rates of change) but also the changing mix of farms, especially if exits from the industry involve large numbers of atypical farms. This article demonstrates how, for the Australian dairy industry, these two processes have combined to generate rates of change in the industry "average" farm, and provides estimates of the underlying on-farm rates of change for those farms remaining in the industry.

### 1. Background

The sources of the economic pressure faced by the Australian dairy industry during the 1970's were both domestic and external. Domestically, butter consumption declined by 43 per cent between 1970 and 1980 (Figure 1). Exports of Australian dairy products declined by 48 per cent. Although domestic consumption of cheese expanded quickly, the amounts have been too small to affect the overall picture of substantial declines in consumption of dairy products over the past decade.

The most obvious response to this decline in demand and, hence, reduced industry returns has been the exit of farms from the industry. During the 1970's, the number of dairy farms in Australia declined by 45 per cent, a rate of decline of 5.5 per cent a year.

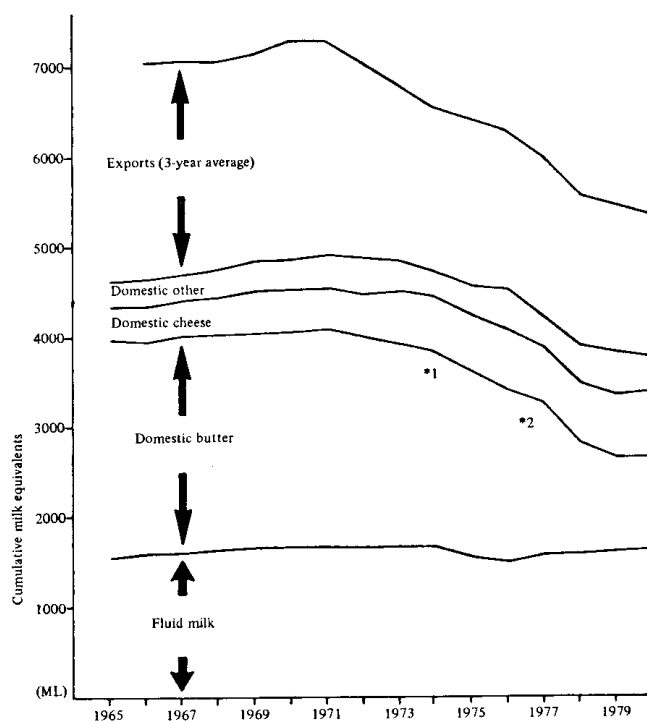
Data from the Australian Bureau of Statistics (ABS), (Figure 2), illustrate in a general way that exits have been mainly from smaller herd sizes, especially in the first half of the decade. Analysis of Bureau of Agricultural Economics (BAE) survey data has shown that about 20 per cent of exiting farms have been amalgamated with other dairy farms. Thus, these resources have remained within the industry. Of those that have physically exited (have been switched to other uses), about 80 per cent have gone to beef production (see Barrett and Gargett 1981).

Another response to economic pressure has been structural adjustment on the farms that have continued in the industry. This has involved changes in the amounts and types of inputs and a general growth in output per farm.

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\* Bureau of Agricultural Economics.

Figure 1: Disposal of Australian Milk 1965-80

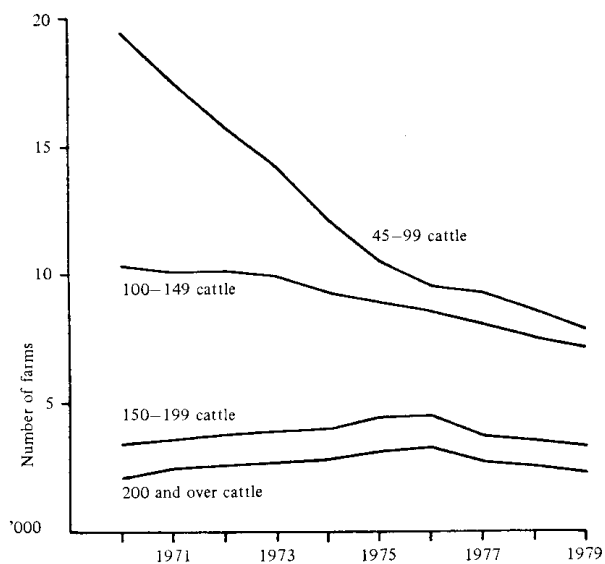


\* 1 Margarine production quotas eased.

\* 2 Margarine production quotas ended.

Source: BAE (1980).

Figure 2: Change in Number of Farms by Herd Size Category, Australian Dairy Industry 1970-79



Source: ABS (1980).

The changes in the industry average farm over time (as depicted in aggregate industry statistics) reflect not only changes on continuing farms but also the 'population effect' associated with exits from the industry. Even if there were no change on continuing farms, the industry average farm would change if exiting farms showed different characteristics. For example, suppose a survey showed an industry consisting of five farms with outputs of 20, 20, 80, 80 and 80 units, respectively. The output of the average farm is 56. However, if the two smallest farms were to leave, the industry average would jump to 80, without any change at all on the remaining farms. Something similar to this process occurred in the Australian dairy farming industry over the 1970's and is termed 'the population effect associated with exit' in this article. The changes in the average farm (as depicted in aggregate industry statistics) are the sum of 'on-farm' change on continuing farms, plus the 'population effect associated with exit' (or associated with entry, for the same population effect can occur in an expanding industry).

The objective of this article, then, is to estimate how much of the change in dairy industry farm characteristics represents actual on-farm change, and how much has been caused by the population effect associated with exits. The approach to the problem is divided into four main sections. The first examines some aspects of methodology and data. The second identifies characteristics which differentiate exit farms from continuing farms. The third presents estimates of on-farm and industry rates of change, and examines their usefulness in understanding changes in aggregate industry output. The fourth examines some of the implications of the estimates for projections.

## **2. Some Aspects of Methodology**

### **2.1 Characteristics Expected to Differentiate Exit Farms**

In examining the causes of farm exits, it was hypothesized that several characteristics of dairy farms were related to the probability of particular farms leaving the industry. The general hypothesis was that exits from the dairy industry have occurred mainly among farms that were smaller, less intensive, less specialized, less profitable, and slower to take up technology—i.e., the marginal farms in the industry.

Also considered relevant to the causes of exit were general economic factors (e.g., the relative profitability of alternative agricultural production, land prices), and operator characteristics (e.g., age, education, previous job experience). However, both these types of factors were found to affect the divergence between on-farm and industry rates of change only in so far as they are associated with differences in the types of size and efficiency characteristics outlined in Table 1.

### **2.2 Data Considerations**

The empirical tests of the hypothesized relationships were made using data from the Australian Dairy Industry Survey. Survey farms were classified as continuing farms or exiting farms for the two periods 1970–74 and 1974–79. The characteristics were based on 3-year averages measured immediately preceding these two periods (i.e., they were averages of 1968–70 and 1972–74 data). Characteristics were measured prior to the periods of classification

because some farms exited at the beginning of the periods. Three-year averages were used in order to smooth out any random year-to-year changes in farm characteristics.

For the purpose of deriving estimates of rates of change, the decade was divided into the two periods 1970–74 and 1974–79. The year 1974, the dividing line between the two periods, neatly separates on one side the beef ‘boom’ of 1973–74 and, on the other, the beef and dairy product ‘slump’ of 1975–77. In addition, 1974 marked the end of the period of rapid decline in the smallest herd size category (Figure 2). After 1974, the rates of decline in all herd size categories become roughly similar. This suggests that the divergence between industry and on-farm rates of change should be much higher in the first period than in the second.

### 2.3 Methods and Assumptions used in Estimating Rates of Change

In estimating *industry* rates of change, figures from both the BAE and ABS were used. There is a problem in comparability however, as ABS records all farms with one or more dairy cattle, whereas the BAE counts only those with more than 45 cattle (equivalent to more than 30 cows). Cattle in herds with less than 45 cattle are not counted by the BAE, which will result in lower BAE numbers and milk production than ABS estimates. Thus, in order to adjust ABS figures to be comparable with BAE figures, the ABS figures were multiplied by .95. This adjusts for the approximately 5 per cent of cattle and milk coming from very small herds.

Estimates of *on-farm* rates of change in the period 1970–74 were derived by examining 361 farms that were in the BAE surveys of both 1970 and 1974 (see Table 1 for sample sizes). This large degree of overlap in the two surveys made possible direct estimates of on-farm rates of change on continuing farms during the early 1970’s.

*On-farm* rates of change for the period 1974–79 were calculated by comparing (1) the 1974 means of the group of continuing farms from the BAE 1974 survey, with (2) the 1979 means for the average farm in the BAE 1979 survey. The implicit assumption was that the average industry farms in 1979 would match those farms that continued during the previous years (the exit farms having left). Thus, the estimation for the period 1974–79 proceeded by an indirect method in contrast to the direct method used for 1970–74. However, application of the indirect method to the 1970–74 period produced similar results to those obtained with the direct method. For example, the direct method gave an estimated 4.0 per cent a year rate of increase in cow numbers in 1970–74. The comparable indirect estimate was 3.7 per cent.

## 3. Characteristics Distinguishing Exiting Farms from Continuing Farms

The results of the empirical tests of differences between exiting and continuing farms are given in Table 1. Exiting farms were significantly different (at the 1 per cent level) from continuing farms for all variables considered in the first period, and for six out of the eight variables considered in the second period. The characteristics of exiting farms seem to have changed between the two periods, a point which is discussed later in this section.

It can be seen from Table 1 that exit farms in both periods were smaller than continuing farms. Milk production on exit farms was 50 per cent of that on continuing farms in 1970, and 70 per cent in 1974. Exit farms in 1970 had an average of 47 cows as against 69 cows for farms which continued in the industry over the next four years. In 1974, exit farms had 63 cows as against 83 for farms continuing in the industry from 1974 to 1979.

Exit farms in both periods also tended to be the less intensively farmed properties and the less specialized properties. These characteristics were significant for exit farms in the first period but not in the second period.

The return to capital and management showed significant and substantial differences in both periods. For example, for farms exiting between 1970 and 1974, the average return to capital and management in the period 1968-70 was -0.8 per cent. It was 3.0 per cent for those remaining in the industry. The return to capital and management variable measures the percentage rate of return to capital, after cash costs (excluding interest and rent), depreciation, and unpaid labour have been costed. Similarly, relative income (the ratio of net cash income plus off-farm wages to average yearly earnings in the rest of the economy) showed that the exit farms in both periods had significantly and substantially lower incomes than continuing farms.

The proportion of cream delivery in the periods under consideration usually took the value of 100 per cent if the farm produced cream and delivered it in cans to the factory. Table 1 shows that, in both periods, exits came more readily from among cream producers. Cream producers were under technological pressure in an industry that was making the transition to bulk milk pick-up in the late 1960's.

The percentage of market milk (as opposed to manufacturing milk) in a farmer's total deliveries does not bear a constant relation to exit. In the period 1970-74, farms leaving the industry seem to have been small farms without any quota. In the period 1974-79, the relationship appears to have been the reverse of that in 1970-74. Exit farms in the latter half of the decade seem to have been the small farms which had previously had some quota in 1972-74.

In testing whether the nature of exit farms had changed between the two periods, it was concluded that exit farms were smaller than the average to a greater degree in 1970-74 than they were in 1974-79. They were also less intensive, less specialized, slower growing and had less access to market milk production in 1970-74 than in 1974-79. However, exit farms in both periods seemed equally unprofitable in relation to the averages, and equally more likely to be cream producers. Thus, in physical characteristics, the exit farms in the late 1970's appeared to be less marginal than average, when compared with the exit farms in the early 1970's. This was a function of the extreme concentration of exits in the smaller herd size category in the early 1970's. By the latter half of the 1970's, this trend had been replaced by the general economic pressure of the dairy slump, which spread the declines among all size groups. The distinguishing characteristics of exit farms in this latter period became more concentrated on low profitability and cream production.

Thus, it has been shown that exits from the Australian dairy industry came mainly from among marginal farms especially in the first half of the decade. Similar findings emerged from a study by Barrett and Gargett (1981). This difference between the characteristics of exiting farms and continuing farms is fundamental to the divergence between on-farm and industry rates of change in a declining industry.

## 4. Industry Versus On-Farm Rates of Change

### 4.1 The Period 1970–1974

Estimates of *industry* rates of change during the period 1970–74 are shown in Table 2. Industry rates of change are calculated by comparing two ‘snapshot’ measurements of the industry at two different dates. Such rates of change estimated by the BAE and ABS are quite similar for milk production and cattle numbers. The industry rates of change are quite high, with the yearly change in milk production being in the 3–4 per cent range, and the yearly change in cow numbers approaching 6 per cent.

Estimates of *on-farm* change are also presented in Table 2, along with a calculation of the divergence from industry rates of change. On-farm rates of change are the rates of change occurring on farms that continue in the industry. They should be different from the industry rates of change if the exit (or entry) of farms is removing (or adding) farms that are dissimilar to those that continue in the industry. A comparison of the two rates of change in the dairy industry reveals that the on-farm rates of change are lower than the industry rates. For example, the on-farm rate of increase in herd size was 1.3 per cent a year, as against a 4.9 per cent industry rate of increase. For milk production, the comparison was 1.9 per cent as against 3.4 per cent. Net farm income actually declined by 0.3 per cent on continuing farms, as against an increase of 4.0 per cent on the industry ‘average’ farm. Much of the ‘apparent’ improvement in the industry average has come simply from the exit of marginal farms.

### 4.2 The Period 1974–1979

Estimates of *industry* rates of change during the latter part of the decade are shown in Table 3. Again, the BAE and ABS figures are in general agreement. A comparison between Table 3 and Table 2 shows that industry rates of change for physical characteristics were slower in the second half of the decade.

*On-farm* rates of change for the period are also presented in Table 3. Again, as expected, they are lower than the industry rates. For example, the on-farm rate of increase in herd size was 0.8 per cent, as against an industry rate of 1.4 per cent. Similarly, the on-farm rate of increase in milk production was 2.4 per cent, as against an industry rate of 3.0 per cent. Net farm income increased by 4.6 per cent on continuing farms and by 6.6 per cent on the industry ‘average’ farm.

Table 1: Differences Between Continuing and Exiting Farms in the Australian Dairy Industry: 1970-74 and 1974-79

Variable	Unit	Farms classified for 1970-74				Farms classified for 1974-79			
		Continuing (n=361) 1968-70 averages	Exiting (n=117) 1968-70 averages	t-value	1-tailed probability a b	Continuing (n=311) 1972-74 averages	Exiting (n=72) 1972-74 averages	t-value a	1-tailed probability a c
Milk production	L	188 738	95 105	-6.47	***	241 144	168 130	-3.60	***
Dairy cows	no.	68.8	47.4	-4.85	***	83.3	63.4	-3.08	***
Milk production per hectare	L/ha	2 047	1 169	-5.64	***	2 551	2 266	-0.96	
Specialization ratio (dairy receipts/total receipts)	ratio	0.6907	0.5384	-7.13	***	0.7233	0.6934	-1.08	
Return to capital and management	%	3.0	-0.8	-6.00	***	3.1	-1.0	-5.78	***
Proportion cream deliveries	ratio	0.2387	0.5806	7.64	***	0.1165	0.2371	2.60	***
Proportion fluid milk	ratio	0.2147	0.1145	-3.44	***	0.1794	0.2984	3.12	***
Relative income d	ratio	1.9345	1.3700	-3.26	***	1.3618	0.9213	-3.43	***

a Higher absolute values of the t-statistics indicate differences at a higher significance level between the means of the two groups. See Blalock (1972, pp. 177-200). b Degrees of freedom = 476. c Degrees of freedom = 381. d Net cash income plus off-farm income divided by average yearly earnings in the rest of the economy.

blank = probability greater than 1 in 10 of such a difference being due to chance.

\* = probability less than 1 in 10 of such a difference being due to chance.

\*\* = probability less than 1 in 20 of such a difference being due to chance.

\*\*\* = probability less than 1 in 100 of such a difference being due to chance.

Source: BAE (1973, 1975) and further BAE analysis.



Table 2: Rates of Change Among Australian Dairy Farms: 1969-70 to 1973-74

Data source	Characteristic	Unit	1969-70 figure		1973-74 figure		Industry rate of change	On-farm rate of change <sup>a</sup>	Divergence of industry rate from on-farm rate
			Industry average farms	Continuing farms	Industry average farms	Continuing farms			
ABS	Milk production <sup>b</sup> Number of cattle <sup>b</sup>	L no.	195 347 109.9		228 113 126.9		% p.a. 4.0 3.7	% p.a.	% p.a.
BAE	Milk production .. Number of cattle .. Number of cows .. Total dairy produce .. Total gross farm returns .. Total farm costs <sup>c</sup> .. Net farm income <sup>d</sup> .. Return to capital and management (adjusted to full equity) <sup>e</sup> .. Total capital ..	L no. no. \$ \$ \$ \$ \$ \$ \$	197 976 109 68 9 891 14 959 8 963 5 996 4 009 73 109	232 158 117.7 73.4 11 463 16 777 9 495 7 282 5 571 80 107	239 791 125 85 14 980 21 266 14 241 7 025 3 663 127 751	244 396 126.8 85.7 15 211 21 660 14 465 7 195 3 834 130 906	4.9 3.4 5.7 10.9 9.2 12.3 4.0 -2.2 15.0	1.3 1.9 4.0 7.3 6.6 11.1 -0.3 -8.9 13.1	3.6 1.5 1.7 3.6 2.6 1.2 4.3 6.7 1.9

<sup>a</sup> Relative standard errors on these change variables expressed as a percentage, were calculated. In order of appearance of the variables they are: 43.4, 29.6, 16.7, 8.6, 10.2, 7.5, 438, 20.9, 5.9. Due to problems in accessing the data at a disaggregated level, no other RSE's were calculated. <sup>b</sup> Adjusted to a "more than 45 cattle" definition of a dairy farm. <sup>c</sup> Cash costs (excluding interest and rent) plus imputed family labour, plus imputed depreciation. <sup>d</sup> Using costs as defined. <sup>e</sup> Net farm income, as defined, minus imputed operator labour plus interest and rent costs.

Sources: ABS (1980); BAE (1973, 1975) and further BAE analysis.

Table 3: Rates of Change Among Australian Dairy Farms: 1973-74 to 1978-79

Data source	Characteristic	Unit	1973-74 figure		1978-79 figure	Industry rate of change	On-farm rate of change	Divergence of industry rate from on-farm rate
			Industry average farms	Continuing farms	All farms			
ABS	Milk production <i>a</i>	..	228 113		264 003	% p.a. 3.0	% p.a.	% p.a.
	Number of cattle <i>a</i>	..	126.9		113.3	1.0		
BAE	Milk production	..	239 791	247 317	278 181	3.0	2.4	0.6
	Number of cattle	..	125	128.7	134	1.4	0.8	0.6
	Number of cows	..	85	87.1	92	1.5	1.0	0.5
	Total dairy produce	..	14 980	15 383	29 600	14.6	14.0	0.6
	Total gross farm returns	..	21 226	22 383	42 364	14.8	13.6	1.2
	Total farm costs <i>b</i>	..	14 241	14 644	32 673	18.1	17.4	0.7
	Net farm income <i>c</i>	..	7 025	7 739	9 691	6.6	4.6	2.0
	Return to capital and management (adjusted to full equity) <i>d</i>	..						
	..	..	3 663	4 357	2 965	-4.1	-7.4	3.3
	Total capital	..	127 751	127 563	175 363	6.5	6.6	-0.1

*a* Adjusted to a "more than 45 cattle" definition of a dairy farm. *b* Cash costs (excluding interest and rent) plus imputed family labour, plus imputed depreciation. *c* Using costs as defined. *d* Net farm income, as defined, minus imputed operator labour plus interest and rent costs.

Sources: ABS (1980); BAE (1975) and further BAE analysis.

Because the exit farms of the early 1970's were relatively numerous and extremely dissimilar to continuing farms, the divergence between on-farm and industry rates of change was greater for the early 1970's than for the latter part of the decade. For the early part of the decade, the average divergence between the aggregates presented in Table 2 was 3.0 per cent (i.e., industry rates of change exceeded the on-farm rates by 3.0 per cent). For the period 1974-79, the comparable average divergence was 1.1 per cent.

### 4.3 Usefulness of the Estimates in Explaining Changes in Aggregate Production

The estimates presented above help in explaining the decline of total output over the 1970's. Specifically, the change in total output of milk is the sum of the negative effect of exit farms withdrawing milk production, and the positive effect of continuing farms expanding their production of milk. As aggregate milk production fell over the 1970's, obviously the exit effect outweighed the on-farm expansion.

Table 4 presents estimates of these negative, positive and total effects on milk production in the two periods. In the period 1970-74, calculated estimates of the total change in total milk production are similar to ABS estimates. These show that exiting farms accounted for the loss of about two and a half times the amount of milk that was added by expansion on continuing farms. As a consequence, total milk production declined by about 500 ML.

Table 4: *Estimates of the Composition of Change in Total Milk Production: 1970-74 and 1974-79: Australian Dairy Industry*

Data Category Source	Numbers of farms	Farm production	On-farm percentage change	Change	
				Per farm	Industry total
	no. <i>a</i>	ML	%	ML	ML
BAE Exit .. .. .	7 152	0.118	1970-74 -100	-0.118	-843
BAE Continuing Expansion	27 980	0.232	+5.3	+0.0122	+341
BAE Total change .. .. .					-502
ABS Total change <i>b</i> .. . .					-480
BAE Exit .. .. .	7 299	0.174	1974-79 -100	-0.174	-1 270
BAE Continuing Expansion	20 681	0.247	+12.5	+0.0308	+636
BAE Total change .. .. .					-634
ABS Total change <i>b</i> .. . .					-923

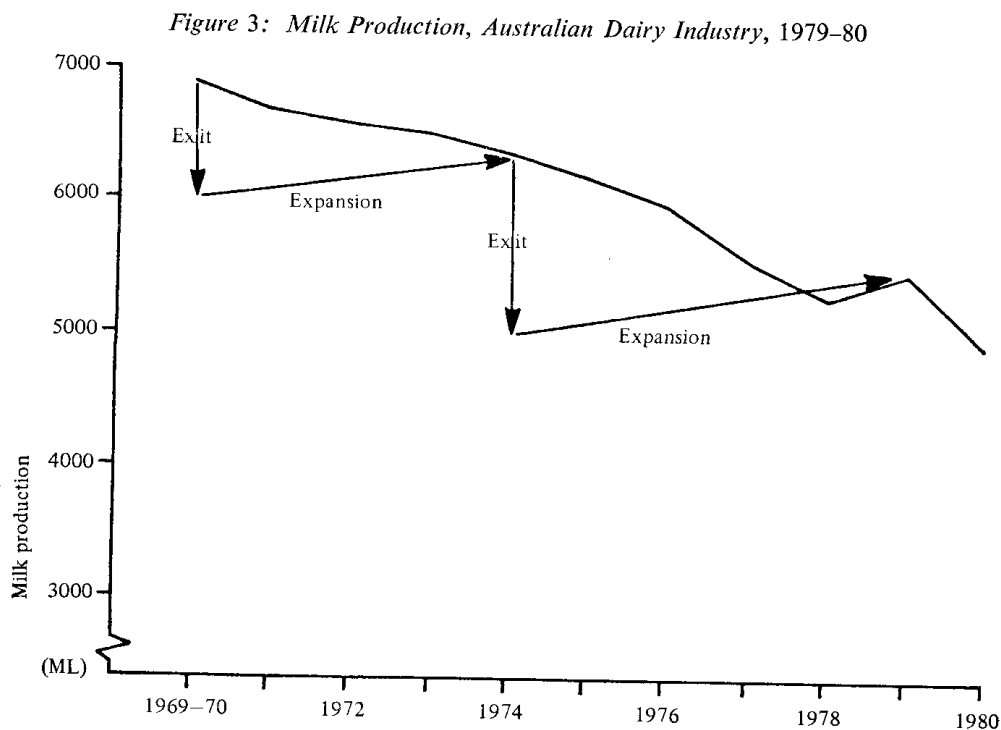
*a* Farm numbers are drawn from ABS—i.e. the number of herds of more than 45 cattle.

*b* Adjusted to a "more than 45 cattle" definition of a dairy farm.

Sources: ABS (1980); BAE (1973, 1975) and further analysis.

In the second period, the total calculated change is not similar to the change derived from ABS estimates. However, the size of the discrepancy is relative to the magnitudes being predicted, i.e., a 300 ML error versus the 1300 ML and 600 ML figures calculated for exit and continuous expansion. One explanation for the difference arises from difficulties in classification of farms as exiting or continuing in the second period, which led to some farms being classed as 'unknown'. This may have introduced some systematic bias into the estimates of exit farm production and the expansion of continuing farms. On the other hand, the period 1974-79 saw major changes in the way in which ABS estimated total milk production and it is quite possible that some of the discrepancy lies in differences in ABS procedures, over the period, for estimating a volume of production that was of the order of 5500-6500 ML. Bearing this in mind, the estimate that exit farms in 1974-79 accounted for the loss of about twice the milk added by expansion of continuing farms is perhaps still valuable. In New South Wales for example, it has been estimated that exit farms during the period 1976-79 accounted for two and a half times the milk added by expansion on continuing farms (Barrett and Gargett 1981).

Figure 3 presents these changes and illustrates how the expansion on continuing farms has partially offset the declines in milk production due to exiting farms. These increases in production occurring on continuing farms, together with the large numbers of marginal farms exiting since 1970, mean that the industry is now much more commercially viable than was the case at the beginning of the 1970's.



## 5. Implications for Projections

In general, the experience of the Australian dairy industry over the 1970's shows that divergences between on-farm and industry rates of change in a declining industry can be important, especially for longer term projections. This is generally true in cases where the number of farms leaving is large and where these farms are very dissimilar to the rest of the farms in the industry. Taking milk production per farm as an example and assuming that the on-farm rates of change on continuing farms over the 1970's were as estimated, the production of milk per farm by farms continuing in the industry would have increased by about 18.6 per cent over the nine years considered. By contrast, the industry 'average farm' percentage increase (judged from ABS census figures adjusted to a 'more than 45 cattle' definition) was 35.1 per cent over the same period. Thus, the industry increase over the 1970's in the 'average' farm's production seems to have been close to double the actual increase in a continuing farm's production. If the nature of the farm exits from the industry, or their numbers, change (which on the evidence available, seems to be occurring), then the projections made using industry rates run the risk of being substantially incorrect.

Even after having isolated on-farm rates of change appropriate to different periods, one must still decide which rate to use for projection purposes. There are two guides to this decision. One is to use a period during which the economic conditions most closely parallel the period for which prediction is being attempted. The second is to use indicators which are not subject to seasonal conditions.

Consider the example of trying to predict the on-farm increase in milk production for the period 1979-82. One's first impulse would be to use the on-farm rates of increase in milk production for 1974-79 from Table 3. But Figure 3 shows that the end year, 1978-79, was an atypically good one for the industry. For projection purposes then, one would like to use milk production adjusted for seasonality, or make use of underlying on-farm trends in cow numbers or herd numbers, as better indicators of long-term growth in production potential.

Secondly, it is not at all certain that for predicting the 1979-82 period one would want to use the 1974-79 on-farm rates. The period 1974-79 was one of hard times in the dairy industry, while the 1979-82 period has been much better. If that had been foreseen when the projection was planned, then it would have been better to use the on-farm rates of change in cattle and cow numbers in the 1970-74 period, as this was a more comparable period. This would have resulted in a 2-4 per cent on-farm rate of increase being adopted, as opposed to a 1 per cent rate, had 1974-79 data been used.

Looking at Table 4, it can be seen that the on-farm percentage change is only one of the figures needed to project the total change in aggregate output. The numbers of exiting and continuing farms must also be predicted. In addition, the volumes of production associated with these farms must be estimated.

In addition, if projections are desired, the method outlined above is only one of many which should be used in combination. For example, a leading indicator method, using numbers of heifers on farms, suggests that a turning point in the total cow population (and, therefore, in milk production) was reached in 1981-82, marking the end of the period of decline in milk production that characterized the 1970s.

## 6. Summary

Farms leaving the Australian dairy industry during the 1970's were dissimilar to farms that remained in the industry. Specifically, they were smaller, less intensive, less specialized in milk production, less profitable, and more likely to be cream producers than farms remaining in the industry.

Because these marginal farms left the industry, average characteristics of the industry appeared to improve simply by the effect on the population of these exits. This phenomenon gave rise to a divergence between rates of change apparent from estimated industry averages as opposed to estimated on-farm rates of change for farms continuing in the industry.

In general, the experience of the Australian dairy industry over the 1970's shows that divergence between on-farm and industry rates of change in a declining industry can be quite important. Taking milk production per farm as an example, and assuming the on-farm rates of change on continuing farms over the 1970's were as estimated, then production of milk on farms remaining in the industry increased by about 18.6 per cent over the nine years considered, almost half the industry 'average' farm's increase of 35.1 per cent. The estimates illustrate quite clearly that continuing farms in the Australian dairy farming industry have been growing much less quickly than the average farm that emerges from industry statistics.

Having gone through a period of extensive adjustment, the industry at the beginning of the 1980's appears to be stabilizing. Individual continuing farms in the industry are much more viable than at the beginning of the 1970's and, overall, the industry seems to be on the verge of reversing the downward trend in milk output that marked the 1970's.

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