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An analysis of the growth of the Australian dairy and meat processing sectors

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Abstract

The dairy and meat processing sectors are significant contributors to the Australian economy. It generates employment and export earnings. For example, processed dairy and meat products accounted for 35 per cent of total food exports in 2000. Hence, the growth of the dairy and meat processing sectors is an important issue for Australia.

The dairy and meat processing sectors grew annually by 1.47 and 0.37 per cent respectively from 1980 to 1998. A third of the growth in the dairy processing sector arose from productivity gains.

Research expenditures, programs such as work place reforms and changes in the exchange rate significantly influenced the productivity changes in the dairy and meat processing sectors.

Introduction

The growth of the food processing sector is important to the Australian economy in a variety of ways. In addition to its impact on those who have a direct stake in food processing operations, the sector influences the welfare of producers of the raw inputs, retailers and consumers of the final products.

The growth in food processing also influences the wider economy. The sector is an important part of Australia's manufacturing base, contributing significantly to the domestic economy, to employment and to trade. Consequently, the growth of the sector is of major interest to policymakers, most recently demonstrated in the development of the National Food Industry Strategy late in 2001 aimed at facilitating the further development of food industries.

This paper presents the results of an exploratory research into the factors influencing growth of the processed dairy and meat industries. Issues examined in the paper include key features of the dairy and meat sub-sectors within the overall food processing sector. Estimates of the contributions of major factors, such as the contributions of labour, capital and technological progress, to the growth of the processed dairy and meat industries are presented. Some key findings and issues are then discussed.

Meat and dairy processing in the food industry

The processed food and beverage sector is a major part of Australian manufacturing. In 1999-2000 the food processing sector had around 3400 business establishments and a total of 164 000 employees, representing 18 per cent of total employment in manufacturing industries, and accounting for 22 per cent of total manufacturing turnover.

The meat and dairy processing industries are the leading components of the food processing sector. The meat processing industry (comprising abattoirs, poultry processing and bacon, ham and smallgoods companies) had total estimated sales of A$10 billion in 1999-2000, 21 per cent of total food manufacturing turnover. While smaller, the dairy processing industry had total sales of AUD $8.2 billion, that is approximately 17 per cent of total food manufacturing turnover.

Both the meat and dairy processing industries have a strong export focus, contributing nearly 14 per cent by value to total Australian merchandise exports in 1999-2000. Over 36 per cent of meat processing sales revenue in 1999-2000 was derived from export sales — mainly meat to Japan and the United States. Exports (mainly milk powders and cheese products) accounted for around 20 per cent of dairy processing sales with ASEAN countries and Japan being the main markets. However, both industries are relatively small participants in world trade. In 1998, the Australian share of world trade in processed meat was 4 per cent and 3 per cent, respectively.

In 1999-2000 employment in meat processing was nearly 48 000, while the dairy processing industry employed 17 300 people. These account for 29 per cent and 10 per cent, respectively, of total food manufacturing employment. A significant part of both industries is based in non metropolitan regions and is an important contributor to rural employment. In the 1996 census, it was found that around 54 per cent of direct employment in the meat and dairy industries was in non metropolitan regions.

Structural patterns and programs in the Australian dairy and meat processing industry

The dairy industry has been undergoing major changes over a long period, including the full deregulation of the industry on 1 July 2000, ending a long period of government involvement in regulating farm gate milk prices and production. Support for producers supplying the fresh milk market, the high value part of the dairy market, was removed. Consequently around 120 dairy processing companies were operating about 206 establishments in 1999-2000 (table 1).

Table 1: Food processing industry in 1999-2000: meat, dairy and total manufacturing

	Number of establishments	Employment [b]	Sales turnover	Exports	Industry value added [a]
	no.	no.	$m	% of turnover	$m
Food and beverage processing	**3 419**	**163 695**	**50 321**	**22.1**	**13 916**
Meat processing	**607**	**47 781**	**10 958**	**36.4**	**2 626**
Meat processing	292	27 784	7 038	55.8	1 523
Poultry processing	155	13 241	2 543	0.7	750
Bacon, ham and smallgoods	160	6 756	1 377	2.6	353
Dairy processing	**206**	**17 233**	**8 348**	**19.5**	**1 872**
Milk and cream	57	6 114	3 027	4.4	640
Ice cream	32	2 505	728	6.2	172
Dairy products	118	8 614	4 593	31.5	1 060
Total manufacturing	**na**	**932.8**	**231 145**	**17.5**	**36 834**

a Industry value added is the total sales plus closing inventories less opening inventories minus selected operating expenses, not including labour and salary costs.

b Employment at 30 June.

Source: ABS, *Manufacturing Industry 1999-2000*, cat. no. 8201.

Industry rationalisation has been a key feature of the dairy processing industry, with company mergers providing opportunities for economies of scale. The dairy manufacturing sector has become increasingly concentrated since the mid-1990s with the top 10 per cent of firms accounting for 61 per cent of sales in 1998-99 compared with 45 per cent in 1995-96. Over the same period, sales concentration in the milk and cream sector actually fell, with the top 10 per cent of firms accounting for 37 per cent of sales in 1998-99 compared with 51 per cent in 1995-96. This could likely be due to the industry re-structuring and pricing effects of the deregulation process. For instance, the deregulation policy discontinued price pooling arrangements on major dairy manufacturing products. However, Decouliagos and Hone (2000) argued that deregulation gave incentives for firms to upgrade their technology and increase capacity. This likely led to increased merger activity since 1998-99 that could likely have increased the industry concentration levels. In that time, three firms (that is, National feeds, Dairy Farmers and Pamalat) purchased out many independent suppliers (Perkins 2001).

The three main sectors of the dairy processing industry are establishments specialising in the processing of milk and cream, ice cream and manufacture of other milk products, including butter, cheese and dried milk products. Over half of total industry sales revenue is generated by the manufactured products sector, with export sales accounting for around 40 per cent of their total sales. Milk and cream processing was the second largest sector with around 36 per cent of total industry revenue.

Industry concentration and economies of size have strengthened in the poultry processing industry where the proportion of sales generated by the top 10 per cent of firms increased from around 40 per cent in 1995-96 to 70 per cent in 1998-99. In the abattoir sector there has been very little change in industry concentration, with the proportion of sales held by the top 10 per cent of firms rising from 55 per cent in 1995-96 to 63 per cent in 1998-99. Hence, a rise in productivity due to economies of scale would likely be modest for the abattoir sector

Output growth patterns and its sources of growth

Many factors influence the development of food processing activities in Australia. Changes in the availability of raw inputs for processing and of other inputs, technology used and industry structure all have impacts on the industries involved. To examine some of these factors, an output growth accounting model was applied to the meat and dairy industries over the period from 1980–98 to identify longer term trends in the productivity of labour, capital and the role of technological change. In undertaking this task, in the absence of detailed data, it was necessary to aggregate the components within each of the industries.

The Australian New Zealand Standard Industrial Classification (ANZSIC) system was used in aggregating the basic data used in the growth analysis. This classification is consistent with the International Standard Industrial Classification ((ISIC) See Hong and Chavoix-Mannato 2000, p.4). The basic data on outputs and inputs were assembled and collected from various sources such as ABARE (1987, 1994, 1999), ABS (various issues from 1977 to 2000), AFFA (2001) and BTRE (2000).

In the growth accounting approach, the rate of growth in the output (G_O) of the dairy or meat processing industry **can** be expressed as the cost-share (S_i , where i = L (labour), K (capital) and OI (other inputs refer mostly to intermediate inputs such as fuel) weighted sum of the rate of growth (G_i) in inputs plus a residual term measuring growth in total factor productivity (G_{TFP}):

$$G_O = S_L G_L + S_K G_K + S_{OI} G_{OI} + G_{TFP}$$

Because output is usually measured in value terms, an additional term reflecting price changes could be added to the growth components.

In this analysis, *GTFP* was estimated through the framework developed by Diewart and Morrison (1986) and applied by Gopinath et al (1997) in their study of the US food processing industry. Diewart and Morrison (1986, p. 662) showed that given profit maximising behaviour in each period among firms in a competitive environment, total factor productivity was equal to the translog implicit output index divided by the translog input index.

The Diewart and Morrison approach has two advantages over other methods. First, it measures the total factor productivity index as a geometric mean, thereby resolving the issue of whether to use the past or the more recent base outputs and prices in estimating it. Second, the most current input prices are used in estimating its weights.

Output growth trends and decomposition results

Analysis of growth was undertaken over the period 1980–98 and in three sub periods (1980–86, 1987–92 and 1993–98) to better reflect the impact of changes in trading conditions and policies that might have affected the dairy and meat industries. One such policy was dairy equalisation whereby dairy farmers paid a levy of $0.02 per litre produced for domestic consumption between 1986 and 1995. Dairy processing firms also paid a levy of $0.04 per litre on all milk used in the production of cheese, powdered milk, butter and other manufactured dairy products for domestic sale.

Productivity growth in the dairy processing sector

Comparing productivity changes in the producer sector with those in the processing sector gives a more complete picture of industry productivity. In a study of farm sector productivity between 1977-78 and 1998-99 (Knopke, O'Donnell and Shepherd 2000), the dairy sector was found to have one of the strongest growths in output.

However, this output growth was mainly associated with increased use of inputs, resulting in average annual total factor productivity of just 1.6 per cent. Livestock industries have achieved lower annual growth in output than dairy farms and their productivity gains have also been relatively low, ranging from 0.6 per cent per year for sheep to 2.1 per cent for beef (table 2).

Table 2: Farm level productivity growth and terms of trade: Average annual rates of change 1977-78 to 1998-99, per farm basis

	Outputs	Inputs	Productivity	Terms of trade
	% pa	% pa	% pa	% pa
All dairy farms	4.1	2.5	1.6	–1.1
Broadacre				
Wheat and other crops	4.8	1.3	3.6	–3.1
Mixed crops–livestock	3.6	1.0	2.6	–2.9
Sheep	1.2	0.6	0.6	–2.4
Beef	2.4	0.3	2.1	–2.1
Sheep–beef	0.4	–0.9	1.4	–2.2
All broadacre farms	3.3	0.7	2.6	–2.9

Note: Columns of figures are independent of each other.

Source: Martin, Riley, Lubulwa, Knopke and Gleeson (2000).

The improvements in farm level productivity and the growing total factor productivity found in the Australian dairy processing industry supports a positive view of dairy industry prospects in both global and local markets, with lower processing costs.

Over the period 1980–98, the output of the dairy processing sector grew by 1.47 per cent a year (table 3). Two-thirds of the aggregate growth was due to higher input use and one-third to improved productivity. However, lower prices associated with the growth in output efficiency reduced the growth in value by around 0.6 per cent a year. When disaggregated into sub periods, industry growth and the sources of this growth varied widely, with the period 1980–86 exhibiting strong growth in output and in prices, while technology growth was lower. From 1987 to 1992 there was little growth in the value of processing with increases in input use and in productivity largely offset by lower price levels.

Table 3: Sources of growth in Australian dairy processing GDP

	GDP growth	Real price effect	Input contribution	TFP growth
	% pa	% pa	% pa	% pa
1980–98	1.47	–0.60	1.41	0.66
1980–86	4.85	1.79	2.66	0.40
1987–92	0.21	–1.82	1.05	0.98
1993–98	–0.22	–1.41	1.43	–0.24

Improved factor productivity has made a significant contribution to the growth of dairy processing over the period and could potentially reduce total cost cumulatively by $4 million (see Harberger 1998 for estimation details) over the full period. While growth in GDP has been falling over the last two periods examined, this has been due to strong price effects (with declining real prices of outputs). With the exception of the last period examined (1993–98, when there was some loss in productivity), productivity gains have been an important source of industry growth.

Increased use of inputs was the main factor behind the growth in dairy processing GDP. Over the full period, about half of this growth was due to increased purchases of manufacturing materials (the largest item being raw milk) with increased capital and labour inputs contributing 20 per cent and 14 per cent respectively of the growth (of the 1.4 per cent a year) due to increased input use (table 4).

Table 4: Contribution of inputs to dairy processing GDP growth

	Material inputs	Capital	Labour	Energy	Total input
	% pa	% pa	% pa	% pa	% pa
1980–98	0.79	0.30	0.20	0.12	1.41
1980–86	–0.31	–0.24	0.51	2.7	2.66
1987–92	1.52	–1.39	0.35	0.57	1.05
1993–98	0.78	1.31	–0.12	–0.54	1.43

Material inputs are aggregation of expenses on raw materials. Energy inputs is an aggregation of expenses on coal, electricity GDP is equal to the sum of factor payments.

Productivity growth in the meat processing sector

Between 1980 and 1998, the value of meat processing output increased by 0.37 per cent a year (table 5), a quarter of that achieved by the dairy processing industry over the same period. Declining prices contributed to the low growth overall but, unlike the dairy industry, this was exacerbated by negative productivity growth. All the growth in meat processing GDP was associated with increased input use, mainly material inputs, such as stock for processing.

Table 5: Sources of growth in the Australian meat processing GDP

	GDP growth	Real price effect		Input contribution		TFP growth	
	% pa	% pa		% pa		% pa	
1980–98	0.37	–0.27	(–1.99*)	0.93	(1.86*)	–0.29	(–1.97*)
1980–86	10.08	0.76	(1.39)	4.97	(1.94*)	4.35	(1.16)
1987–92	–6.23	–0.79	(–2.09*)	–1.52	(–2.26*)	–3.92	(1.89*)
1993–98	4.76	1.04	(2.41*)	1.86	(1.94*)	1.86	(1.96*)

All annual growth rate were obtained from logarithmic (base e) regression with time as the independent variable. Numbers in parentheses are the 't' value of the regression coefficient. Single asterisk means significant at the 0.025 level. Material inputs are aggregation of expenses on raw materials. Energy inputs is an aggregation of expenses on coal, electricity GDP is equal to the sum of factor payments.

Examination of meat processing industry growth over the sub periods reveals substantial variations in performance with strong growth in the value of output between 1980 and 1986, with very strong contributions from growth in input use and improved productivity. However, the value of meat processing declined from 1987 to 1992, with negative contributions from purchased inputs, negative relative price movements and also a strong decline in overall productivity. Falling real prices, and lower labour output were the major factors behind this fall (table 6).

Table 6: Contribution of inputs to meat processing GDP growth

	Material inputs % pa		Capital % pa		Labour % pa		Energy % pa		Total input % pa	
1980–98	0.95	(1.89*)	0.48	(1.80)	–0.54	(6.15*)	0.04	(1.78*)	0.93	(1.86*)
1980–86	3.7	(1.98*)	–0.89	(–2.46*)	0.21	(1.49)	1.95	(1.80)	4.97	(1.94*)
1987–92	1.58	(1.95*)	–1.34	(–1.48)	–1.25	(3.62*)	–0.51	(–1.76)	–1.52	(–2.26*)
1993–98	1.22	(1.79)	0.95	(6.0*)	0.44	(1.89)	–0.75	(–1.9)	1.86	(1.94*)

All annual growth rate were obtained from logarithmic (base e) regression with time as the independent variable. Numbers in parentheses are the 't' value of the regression coefficient. Single asterisk means significant at the 0.025 level. Material inputs are aggregation of expenses on raw materials. Energy inputs is an aggregation of expenses on coal, electricity. GDP is equal to the sum of factor payments.

Partial productivity growth in the dairy and meat processing sectors

Partial productivity indexes are ratios of outputs to individual inputs or aggregates of inputs, normally estimated for the major inputs used by a firm or industry. For example, the output per hour of labour is a partial labour productivity index. To a certain extent, changes in partial labour productivity reflect factor substitutions (for example as indicated by the technical elasticity of substitution parameter) and changes in production efficiencies.

Partial labour productivity is measured as:

$O/L = (O/K)*(K/L)$

O is output while *L* and *K* refer to labour and capital inputs. Hence, partial labour productivity can be decomposed into the partial capital productivity and the capital–labour ratio.

The growth in partial labour productivity is:

$G_{O/L} = G_{O/K} + G_{K/L}$

Hence, changes in the partial labour productivity reflect changes in partial capital productivity and changes in the capital–labour ratio. For example, a rising labour productivity could either be due to a rise in capital productivity or a rise in the capital–labour ratio or both. Higher returns to capital relative to labour cost could likely spur the higher use of capital relative to labour employment.

Estimates of the partial productivity for the period 1980–98 and the sub periods are given in tables 7 and 8. For the dairy industry, the growth in labour productivity over the entire period was 3.1 per cent a year but when examined in terms of the sub periods, was characterised by strong growth of nearly 6 per cent a year for the period 1987–92 with growth of around 2.2 per cent a year in the other two sub periods. This was largely achieved through the growth in capital productivity. Except for the period, 1993–98, growth in the capital intensity had been declining.

Table 7: Partial productivity trends in the dairy processing industry

	Labour productivity % pa	Capital productivity % pa	Capital-labour ratio % pa
1980–98	3.1	4.8	–1.7
1980–86	2.3	5.3	–3.0
1987–92	5.7	8.0	–2.3
1993–98	2.2	1.0	1.2

Table 8: Partial productivity trends in the meat processing industry

	Labour productivity	Capital productivity	Capital-labour ratio
	% pa	% pa	% pa
1980–98	0.9	1.9	–1.0
1980–86	0.8	0.7	0.1
1987–92	2.0	6.6	–4.4
1993–98	1.4	3.7	–2.3

In the meat processing sector, labour productivity was much lower, averaging 0.9 per cent a year over the full period and ranging from 0.8 per cent to 2 per cent a year in the sub periods. Although capital productivity grew from 0.7 to 6.6 per cent a year, over the first two sub periods, the capital–labour ratio was declining during the second period, consistent with low rates of capital inflow to the industry (Zsirossy 1996, p. 2).

Other factors affecting productivity growth ın the dairy and meat processing sectors

Investment in research and development infrastructure, training programs and other economic factors can affect the productivity in the dairy and meat processing industries. Since the growth in total factor productivity (TFP) sustains the overall growth of these industries, an analysis of the factors affecting it could provide policy insights. Hence, in this section, the estimated impact of changes in research expenditure on TFP in both industries is reported with the estimates having been obtained through a regression model.

For the period, 1980–98, the regression results for the TFPs are:

Dairy processing sector

$$\text{Log (TFP)} = 11.6 + 0.80t + 3.62\,D_1 + 0.56D_2 - 0.33D_3 + 0.036\,\text{pdar} + 0.0056\,\text{res} - 0.027\,\text{rrate}$$

(2.4) (3.03) (2.71) (1.55) (1.864) (2.25) (3.29) (-1.97)

Numbers in parenthesis are the t-values of the respective regression coefficients.

Adjusted R square = 0.68

DW = 2.16

Meat processing *sec*tor

$$\text{Log (TFP)} = 4.6 - 0.14t + 0.053\,D_1 - 0.099D_2 + 0.37D_3 + 0.011\,\text{pm} + 0.0015\,\text{res} - 0.024\,\text{rrate}$$

(4.30) (-2.64) (.069) (-.1.89) (2.11) (1.66) (2.44) (-3.26)

Numbers in parenthesis are the t-values of the respective regression coefficients.

Adjusted R square = 0.59

DW = 2.38

D_1, D_2 and D_3 are dummy variables that equal 1 when the observation belongs respectively to the periods, 1980–86, 1987–92 or 1993–98, otherwise 0. The variables pdar and pm are the aggregate real price of processed dairy and meat products. The variable res is the real annual research expenditure in million dollars, obtained from the ABS, while t is time.

The variable *rrate* is the real exchange rate that incorporates the differences in the inflation rates among the major trading partners of Australia. Senhadji (2000) similarly used it as an explanatory variable in his TFP study to account for the effect of macroeconomic factors on total factor productivity. The *a priori* sign for the coefficient of the real exchange variable is negative, that is a good macroeconomic environment partly reflected by a lower real exchange rate would enhance total factor productivity (Senhadji p.152, 2000).

The research variable has a statistically significant and positive impact on the total factor productivity of both the dairy and meat processing industries. It supports the important role that research investments can play in achieving a sustainable productivity growth in both industries.

Overall, on the basis of the coefficient for the time variable, the results indicate that TFP is increasing in the dairy processing sector and decreasing in the meat processing sector. The declining trend in relation to productivity in the meat processing sector over time, is a finding supported by other research, particularly Booz and Hamilton (1993). Zsirossy (1996, p. 3) noted that this technology pattern in the meat processing sector could likely be attributed to a slower rate of adoption of better work practices and introduction of technologically advanced equipment.

However, workplace reforms implemented under the agrifood strategy in 1992 appeared to have boosted total factor productivity, as indicated by the positive sign of the D_3 and its statistical significance at the 5 per cent level.

Changes in commodity prices appear to have affected productivity growth in the meat processing industry through its impact on the returns to the adoption of improved technologies. The coefficient of the price variable in the meat processing equation is positive and is statistically significant at the 2.5 per cent level. The meat industry works on relatively thin margins, such that small changes in the relativity between prices paid for slaughter animals and meat prices have a major impact on profitability of processing, influencing the level of investment in research and technological development.

Since changes in exchange rates would affect earnings of dairy and meat processed products that are exported, it is expected that a lower real exchange rate would enhance its export demand. A higher return from export markets due to a lower real exchange rate could likely provide an incentive to adopt modern technologies that would be reflected by a rise in total factor productivity in the dairy and meat processing industries. The coefficient of the real exchange variable is negative and is statistically significant at the 2.5 per cent level.

Conclusions

Being the major export earners and employers in the Australian economy, the growth of the dairy and meat processing sectors is an important economic issue. For it to continue, a key element of the growth process would be the growth in productivity arising from innovative technologies and improved work practices. In this paper, the productivity growth in the dairy and meat processing sectors was analysed through partial productivity and total factor productivity (TFP) indices.

It was shown that the dairy processing sector grew annually at four times higher than that of the meat processing sector from 1980 to 1998. During this period, productivity gains accounted for a third of the growth in the dairy processing sector. Differences in the work practices between the dairy and meat processing sectors could likely and partly account for this trend.

Several factors affected total factor productivity growth in the dairy and meat processing sectors. Investment in research and development infrastructure and training programs contributed significantly to its growth in both sectors. Changes in the real exchange rate that led to higher returns on investments on modern technologies led to total productivity rises in both sectors.

While the TFP indices provided important dimensions of the growth process, it has two main limitations. First, since it is estimated as a residual, it is susceptible to measurement errors. Second, it might not be able to measure the non market costs of growth accurately.

Finally, due to the data limitations, the productivity analysis conducted in this paper was confined to the most aggregate levels for both outputs and inputs. It might be worth exploring a productivity study of the dairy and meat processing industries at a lower levels of aggregation if the precise and relevant data sets are available.

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